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National Statistical Assessment of Rural Water Conditions. Volume 1

Cornell Univ., Ithaca, NY

Prepared for

Environmental Protection Agency, Washington, DC

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National Statistical Assessment of Rural Water Conditions

Volume I

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16. ABSTRACT

This study considered five dominant dimensions of the status of domestic water: quality, quantity, availability, cost and affordability. Rural residents were asked about health effects but the results were modest in that very few rural residents reported adverse health conditions which they associated with the water supply.

With enactment of the Safe Drinking Water Act of 1974, Congress set in motion two major efforts to develop systematic, current data on rural water supplies across the nation. First, in response to growing concern with the quality of drinking water and its effects on human health, the Safe Drinking Water Act provided for a uniform, national set of water quality standards and extended the monitoring and regulatory responsibility of the US Government over smaller water supplies. Second, the Act mandated a one-time national statistical assessment of the current status of rural domestic water characteristics. This document fulfills that mandate.

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National Statistical Assessment of Rural Water Conditions

Report prepared for

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US Environmental Protection Agency

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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

JUN 15 1984

THE ADMINISTRATOR

The President
The White House
Washington, D.C. 20500

Dear Mr. President:

We are hereby transmitting the report on a National Statistical Assessment of Rural Drinking Water Conditions which is mandated by Section 3(a) of the Safe Drinking Water Act, as amended. Section 3(a) requires the Administrator to ". . . conduct a survey of the quantity, quality, and availability of rural drinking water supplies." We have looked in detail at the problem of rural drinking water, and have found that most rural households have a water supply which is acceptable by most quality indicators; is in sufficient quantity to meet consumption demands; is readily available on a continuous basis; has a reasonable cost; and is affordable.

The study is the first systematic national assessment of the quantity, availability, cost, and affordability of rural domestic water. We believe that it contributes much to our understanding of rural drinking water supplies, rural households, and drinking water problems associated with various regions of the United States. The study complements and extends the information from earlier reports and, although much remains to be understood, I believe that it establishes a solid information base on this subject matter.

Respectfully,

William D. Ruckelshaus

Enclosure

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

JUN 15 1984

THE ADMINISTRATOR

Honorable George Bush
President of the Senate
Washington, D.C. 20510

Dear Mr. President:

We are hereby transmitting the National Statistical Assessment of Rural Drinking Water Conditions Study and Report, which is mandated by Section 3(a) of the Safe Drinking Water Act, as amended. Section 3(a) requires the Administrator to ". . . after consultation with the Secretary of Agriculture . . . conduct a survey of the quantity, quality, and availability of rural drinking water supplies." Section 3(a) further requires that the ". . . survey shall include . . . the consideration of the number of residents in each rural area (1) . . . inadequately served by a . . . water supply system; (2) . . . having limited or . . . inadequate access to drinking water; (3) . . . who, due to absence or inadequacy of a drinking water supply system are exposed to . . . health hazard; and (4) who have experienced incidents of . . . illness, which may be attributed to the absence or inadequacy of a drinking water supply system." The report is required to be submitted to the Congress and the President. We have looked in detail at the problem of rural drinking water, and have found that most rural households have a water supply which is acceptable by most quality indicators; is in sufficient quantity to meet consumption demands; is readily available on a continuous basis; has a reasonable cost; and is affordable.

The study is the first national study designed to investigate the status of rural water quality at the point of use in rural households and the first national assessment of the links between the status of domestic water in rural households and characteristics of the supply which provides that water. In addition, it is the first systematic national assessment of quantity, availability, cost, and affordability of rural domestic water supplies.

The National Statistical Assessment of Rural Water Conditions report is divided into four interrelated volumes. The first volume presents, along with a summary and introduction, a discussion of the characteristics of rural water users and households. The second and third volumes present the status of rural water quality and discuss the economics of rural water systems. The fourth volume is the analytical presentation. It examines in detail the factors related to rural water conditions: quality, quantity, availability, and cost.

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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

JUN 15 1984

THE ADMINISTRATOR

Honorable Thomas P. O'Neill
Speaker of the House of Representatives
Washington, D.C. 20515

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William D. Ruckelshaus

EXECUTIVE SUMMARY

Information about rural water conditions has long been fragmentary and incomplete. The information that existed generally has been limited to the results of unsystematic, localized surveys concentrated narrowly on a few prominent local water quality problems. These surveys have not generally employed compatible sample designs or methodologies. As a result, it has been difficult to formulate a unified understanding of rural water conditions, and difficult to devise informed, comprehensive policies and programs for rural water supplies.

To some extent, the absence of wide-ranging and detailed knowledge of rural water conditions is related to the nature of rural water supplies. Rural water systems are frequently individual and small multiple-connection systems, which fall outside the regulatory and funding programs of the major "water agencies" of government. With enactment of the Safe Drinking Water Act of 1974, Congress set in motion two major efforts to develop systematic, current data on rural water supplies across the nation. First, in response to growing concern with the quality of drinking water and its effects on human health, the Safe Drinking Water Act provided for a uniform, national set of water quality standards and extended the monitoring and regulatory responsibility of the US government over smaller water supplies. Second, the Act mandated a one-time national statistical assessment of the current status of rural domestic water characteristics.

The one-time study was to be an intensive examination of a wide range of factors, but for only a sample of households and systems. The institutionalized national monitoring program was to extensively cover a few factors on all community systems. This document is concerned with the intensive, one-time national statistical assessment of rural water conditions.

THE CALL FOR ASSESSMENT AND RESPONSE

The enabling legislation mandating the one-time assessment study was contained in Section 3(a) of the Act. It reads:

> Sec. 3(a). The Administrator of the Environmental Protection Agency shall (after consultation with the Secretary of Agriculture and the several States) enter into arrangements with public or private entities as may be appropriate to conduct a survey of the quantity, quality and availability of rural drinking water supplies. Such survey shall include, but not be limited to, the consideration of the number of residents in each rural area . . .
>
> (1) presently being inadequately served by a public or private drinking water supply system; or by an individual home drinking water supply system;
>
> (2) presently having limited or otherwise inadequate access to drinking water;
>
> (3) who, due to the absence or inadequacy of a drinking water supply system, are exposed to an increased health hazard; and
>
> (4) who have experienced incidents of chronic or acute illness, which may be attributed to the absence or inadequacy of a drinking water supply system.

The study called for in this provision of the Act has been completed and what follows is a summary of the five-volume, approximately 1,900 page report, submitted to Congress in conformance with the stipulations of the Act. The study and report, labelled the National Statistical Assessment of Rural Water Conditions (NSA), focused primarily on the quality, quantity, availability, cost, and affordability of domestic water in rural households throughout the continental United States. Additionally, some corollary information was presented on water systems serving these households.

RESPONSIBILITY FOR THE STUDY

Primary responsibility for oversight of the contents and conduct of the study was allocated to the US Environmental Protection Agency. Within EPA, the national assessment study was placed under the aegis of the Office of Drinking Water. The planning of the content, scope, and execution of appropriate procedures for conducting the study involved the Office of Drinking Water, various private consulting firms, university researchers, and professional organizations. Subsequently, proposals were solicited and a group of rural sociologists from the Department of Rural Sociology at Cornell University was selected to further conceptualize the study, oversee the sampling and data collection, analyze the results, and write the report summarized herein.

In Section 3(a) of the Act, the Administrator of EPA was directed to consult with the Secretary of Agriculture in the formulation and overview of the study. During the formulation stage of study, two meetings were held with a specially formed study group composed of representatives from Farmers' Home

Administration, Economic Research Service of the Economic Development Division, and the Statistical Research Service of the Statistical Division of USDA. The meetings were primarily devoted to discussions of (1) the general scope of the study effort, (2) the types of data to be collected, (3) the manner in which this study effort would complement and inform USDA programs and research, (4) a critique of the conceptual foundations of the study, and (5) the ways in which the data would be analyzed. In addition, FmHA representatives joined a review team composed of experts representing a spectrum of professions, interest groups, and government agencies. This review team met on three separate occasions to critique the analysis and report writing in progress.

SIGNIFICANCE OF THE STUDY

The study summarized here is the first national study designed to investigate the status of rural water quality at the point of use, in rural households. In addition, it is the first systematic national assessment of quantity, availability, cost, and affordability of rural domestic water supplies. It is the first national assessment of the links between the status of domestic water in rural households and characteristics of the supply which provides that water.

Prior to this study, the most complete information, at the national level, about rural water was contained in the Community Water Supply Study: Analysis of National Survey Findings, conducted by the Bureau of Water Hygiene, US Department of Health, Education, and Welfare (1970), and Survey of Operating and Financial Characteristics of Community Water Systems, conducted by Temple, Barker, and Sloane, Inc. for the US Environmental Protection Agency (1977). Studies other than these were either local in scope or examined water pollution in bodies of water located in rural areas, not the characteristics of the water at the point of consumption.

This study complements and extends the information from the earlier reports. But, its focus on the character of the water as it is actually consumed at the household differs from earlier efforts. Additionally, it uniquely provides complementary information about the water supply system. In short, it is the first national portrayal of rural household water conditions and associated system characteristics.

METHODOLOGY AND RESEARCH PROCESS

A review was undertaken of available information and procedures for studying the status of rural domestic water conditions. This review pointed up serious deficiencies in knowledge, conceptual maturity, and methodological tools. A conceptual reformulation and development of data collection procedures was undertaken by the Cornell research group. Members of this group developed the interview schedule in consultation with management and technical personnel at EPA, and with various representatives from other governmental agencies, consulting firms and research groups. The instrument was pretested and refined four times, and the final version was submitted and approved by the Office of Management and Budget.

Data collection involved, at each selected household, personal interviews with occupants, physical inspection of on-premises water supplies, drawing samples of the major household water supply, various observations on sources of potential contamination; and, where appropriate, separate interviews with managers and operators of off-premises water supply systems which provided water to these rural households.

TransCentury Corporation was selected by the EPA, after competitive bid, to administer the data collection activities. Oversight and general coordination of these activities was accomplished in coordination with the Cornell University research group.

Interviewers underwent a two-week intensive training course on all aspects of the data collection effort, including the drawing, packaging, labelling, and transportation of specimens of "tap" water. Quality control of the field work included constant and comprehensive monitoring. Data coders were also intensively trained and monitored.

Water samples collected at each household participating in the study were shipped to central laboratories for analysis of as many as 40 separate biological, physical, chemical, or radiological properties. Responsibility for these analyses was shared by several organizations including the Energy Resources Corporation, the Medical School of the University of South Carolina, the Mississippi State Chemical Laboratory, the EPA-MERL Laboratory (Municipal Environmental Research Laboratory) in Cincinnati, and the EPA-EMSL Laboratory (Environmental Monitoring Systems Laboratory) in Las Vegas.

The sampling plan for the study defined the target population to conform to the US Bureau of the Census' definition of rural population and households: civilian, noninstitutionalized persons located in unincorporated or incorporated places of less than 2,500 population, or located in rural areas not designated as a place. The sample was proportional to rural population (and households) in: (1) the four broad census regions—Northeast, North Central, South, and West; (2) located in areas designated as Standard Metropolitan Statistical Areas; (3) in rural communities of 2,499 to 1,000 population, under 1,000 population, or open country. The county was designated as the primary sampling unit. From the approximately 3,000 counties in the continental US, 400 were selected. Within those counties, a total of 2,654 households and their associated water supply systems were evaluated. They represented an estimated 21,974,000 occupied rural households. Of these, an estimated 8,765,000 households were served by individual, single connection systems; 2,228,000 households were served by 845,000 intermediate systems (two through fourteen connections); and 10,981,000 households were served by 34,000 community systems (fifteen or more connections). Total counts of households and systems were derived using standard statistical weighting procedures. Each unit's weight, in broad terms, was the inverted sampling fraction adjusted for nonresponse.

Collected data were compiled by the Cornell research group for statistical analysis and report production. All aspects of the report underwent extensive scrutiny by various review mechanisms.

MAJOR FINDINGS

This study considered five dominant dimensions of the status of domestic water: quality, quantity, availability, cost, and affordability. Rural residents were asked about health effects but the results were modest in that very few rural residents reported adverse health conditions which they associated with the water supply. Attempts to secure detailed information about the health effects of the water being consumed would have required a large-scale epidemiological investigation, which was not possible within the scope of this study.

Information was secured from both the households and water supply systems. The major findings and conclusions will be presented first from the household perspective, then from information collected at the systems.

WATER QUALITY

Water quality was assessed using as many as 40 indicators, including all of the contaminants given primary and many given secondary maximum contaminant levels (MCLs) by the EPA (see Table 1). The study used the MCL levels to establish benchmarks for comparing various segments of the rural population. These benchmarks, or reference values as they were called, were not totally isomorphic to the MCLs. The MCLs included components which could not be reasonably accommodated in the study such as: (1) retesting provisions; or, (2) in the case of fluoride, a range of MCL values. However, reference values were chosen to match the MCL specified level, whenever possible, to provide perspective on interpretation.

A quality assurance program was in effect in each of the participating laboratories. A follow-up attempt to secure results on the quality assurance was not entirely successful. Some records had been discarded, others were not in an easily usable format, and some were inaccessible. Quantification of the quality assurance results for the purposes of this report was not complete. However, there was no indication that quality assurance programs at the laboratories deviated from quality assurance procedures that were EPA-approved at the time of the NSA study.

The NSA investigation of rural water quality suggested problems of greater magnitude and prevalence (especially regarding mercury, lead, cadmium, silver, and selenium) than had been generally expected, based on data from monitoring community water systems and from other studies. Since it is the first nationally systematic consideration of rural domestic water quality, there is no direct verification of its findings in previous work. There is also no way, within the confines of the study, to absolutely ensure that the reported levels of metals (or the levels of any of the other constituents) were valid indications of water supply contamination, nor to prove they were artifacts induced in some way by the study itself. On the other hand, since no previous study has looked as extensively at individual home supplies, intermediate systems, and small community systems, this study may have been the first opportunity to view the extent of water quality problems. But, rather than conclusively proving the status of rural water quality, the study strongly suggests important avenues for concern, and stands as a guide to further work.

Table 1

Constituents Measured in NSA Survey

Category	Constituent	Has Primary (P), Secondary (S), or No (N) MCL	Measured in All NSA Household Samples or only in Group II Subsample
Microbial	Total coliform	P	All
	Fecal coliform	N	All
	Fecal streptococcus	N	All
	Standard plate count	N	All
	Fecal coliform/fecal streptococcus ratio	N	All
Physical and Chemical	Turbidity	P	All
	Color	S	All
	Temperature	N	All
	Specific conductance	N	All
	Total dissolved solids (as determined from conductance)	S	All
	Hardness (as determined from calcium and magnesium)	N	All
Inorganic	Calcium	N	All
	Magnesium	N	All
	Nitrate-N	P	All
	Sulfates	S	All
	Iron	S	All
	Manganese	S	All
	Sodium	N	All
	Lead	P	All
	Arsenic	P	Subsample
	Selenium	P	Subsample
	Fluoride	P	Subsample
	Cadmium	P	Subsample
	Mercury	P	Subsample
	Chromium	P	Subsample
	Barium	P	Subsample
	Silver	P	Subsample
Organic	Endrin	P	Subsample
	Lindane	P	Subsample
	Methoxychlor	P	Subsample
	Toxaphene	P	Subsample
	2,4-D	P	Subsample
	2,4,5-TP	P	Subsample
Radioactive	Gross alpha	P	Subsample
	Gross beta	P	Subsample
	*Radium 226	P	
	*Radium 228	P	
	*Uranium	P	
	*Stontium-89	P	
	*Strontium-90	P	
	*Cesium-134	P	
	*Tritium	P	
	*Iodine-131	P	

*Measured only if the laboratory analyst considered gross alpha or gross beta readings sufficient to warrant further investigation.

Among those contaminants which are covered by primary MCLs (because they are potential health hazards), total coliform emerged as the most prevalent problem, exceeding the reference value in 28.9 percent of all rural households. Among constituents which tend to be aesthetically objectionable or impose economic costs (e.g., degrading to plumbing, laundry, etc.), iron was the most common.

The presence of total coliform organisms was the most common single problem and received the greatest attention in the analysis. Coliform organisms represent a problem in that they are used as indicators of the possible presence of pathogenic bacteria. The rate of total coliform presence in excess of one coliform per 100 milliliters of water (28.9 percent nationwide) was 15.5 percent among households served by community systems, and over 40 percent among those served by intermediate and individual systems (43.3 and 42.1 percent, respectively). Households served by systems with fewer than fifteen connections that were not wells (i.e., cisterns, springs, surface water, hauled, purchased bottled) had more than one coliform per 100 milliliters of water in 77.7 percent of cases. In general, households with low income (under $10,000) and low education (less than high school) were more commonly found to have coliform problems than other households. Poorly accessible and privately owned supplies tended to have coliform problems more often than other supplies. Households served by dug and bored wells, wells in which the water leaves the casing above ground level, wells with inadequate covers, inadequately maintained wells, and shallow wells all tended to have high coliform levels more commonly than those served by wells without those characteristics. Small systems, with few connections, repeatedly exceeded coliform levels more frequently than most large community systems.

Fecal coliforms were found among 12.2 percent of all rural households, but among only 4.5 percent of households using community water systems. Fecal coliform counts were above 200 organisms per 100 milliliters of water (a suggested upper limit in water used for swimming) for 1.6 percent of rural households.

Standard plate counts of more than 500 organisms per milliliter of water were encountered at 19.3 percent of households. In this case, the percentage of households with the problem, which used community water systems, was not dramatically lower than for those using intermediate and individual systems.

Turbidity was measured above one NTU among 16.5 percent of rural households. That rate varied from 23.8 percent in the North Central to 8.5 percent in the West. Households using community systems were least likely to have more than one NTU readings, 8.9 percent, compared to 24.0 percent for intermediate systems, and 24.7 percent for individual systems.

Color was measured above fifteen standard color units among only 2.3 percent of all rural households.

Total dissolved solids, estimated from specific conductance readings, was found above 500 milligrams per liter among 14.7 percent of all rural households. Households in the North Central and West were over that level 23.9 and 22.2 percent, respectively. The Northeast, on the other hand, had only 5.0 percent of households with levels above 500 milligrams per liter.

Magnesium was found above 125.0 milligrams per liter in only 0.1 percent of rural households.

Nitrate-N concentrations above 10.0 milligrams per liter occurred among 2.7 percent of households. Regionally, the proportion over that level was 0.3 percent in the Northeast, compared to 5.8 percent in the North Central.

Sulfates exceeded 250 milligrams per liter among only 4.0 percent of rural households, but households in the West and the North Central were over at rates of 11.7 percent and 7.4 percent, respectively. The Northeast and South had household supplies at that level in less than 1 percent of the cases.

Iron concentrations over 0.3 milligrams per liter were found in 18.7 percent of all rural households. North Central households exceeded that level among 28.2 percent of households, compared to 7.0 percent in the West. Households served by community water systems were over at the rate of 7.7 percent across the nation. By contrast, the percent of households with iron concentrations over 0.3 milligrams among intermediate and individual systems was 28.7 percent and 29.9 percent, respectively.

The pattern of manganese occurrence was very similar to iron. Households with more than 0.05 milligrams per liter occurred among 14.2 percent of the cases. The rate in the North Central was highest (19.9 percent); and lowest (4.7 percent) in the West. Households served by community systems were over that level at a rate of 7.2 percent, compared to 23.3 percent and 20.7 percent, respectively, among households served by intermediate and individual systems.

Sodium levels higher than 100 milligrams per liter appeared in 14.2 percent of rural households nationwide. That rate was as low as 6.0 percent in the Northeast, and as high as 19.2 percent in the North Central.

Lead was above 0.05 milligrams per liter at 16.6 percent of the households. The percent of households exceeding that level was lowest in the Northeast (9.6 percent) and highest in the South (23.1 percent). It was discovered subsequent to the data collection that a thin line of blue paint which marked the breakpoint on the glass ampules of nitric acid preservative contained cadmium and lead. It is likely that the average lead contamination due to the paint was 36 parts per billion (0.036 milligrams per liter). Assuming relatively constant contamination from the paint at that level, the estimated proportion of rural households over 0.05 milligrams dropped to 9.2 percent nationwide.

Arsenic levels in rural household water were encountered above 0.05 milligrams per liter in only 0.8 percent of all rural households. The preponderance of those households were found in small rural communities (population less than 1,000). Households in those communities were found with the high arsenic levels among 6.6 percent of the cases.

Selenium, nationwide, was found above 0.01 milligrams per liter among 13.7 percent of households. Most of that occurred in the North Central and West. Households in the Northeast and South had high rates in roughly 2 percent or fewer of the cases. In the North Central, that rate was much greater at 25.7 percent, but in the West a remarkable 41.3 percent of all rural households had more than 0.01 milligrams per liter of selenium.

Fluoride concentrations exceeded 1.4 milligrams per liter in only 2.5 percent of all rural households. The rate in the West, at 6.2 percent, was more than double the rate found in any of the other regions.

Cadmium was measured above 0.01 milligrams per liter among 16.8 percent of all rural households. Only 1.6 percent of rural households in the Northeast were over that level while 27.1 percent of those in the West were high. Households served by both community and intermediate systems had the high cadmium rates in more than 20 percent of the cases (21.2 percent and 26.9 percent, respectively) while 7.9 percent of the households with individual systems registered high. Here again, however, the paint on the acid preservative ampules apparently imparted some cadmium background to the readings. The average contamination was probably in the neighborhood of .92 parts per billion (0.00092 milligrams per liter). With that assumption, the national rate of high cadmium values dropped to 15.9 percent.

Mercury was found among 24.1 percent of all rural households to be in concentrations exceeding 0.002 milligrams per liter. That proportion climbed as high as 31.8 percent in the North Central, and dropped as low as 10.4 percent in the West.

Chromium was virtually nonexistent above concentrations of 0.05 milligrams per liter throughout the US.

Barium concentrations over 1.0 milligram per liter were rarely found (0.3 percent of all rural households).

Silver exceeded 0.05 milligrams per liter among 4.7 percent of all rural households. Among the types of systems serving rural America, community systems had the lowest rates (2.1 percent), and individual systems had the highest rates (7.1 percent).

Endrin, lindane, methoxychlor, toxaphene, 2,4-D, and 2,4,5-TP were virtually never detected among rural household water supplies.

Gross alpha radiation in excess of acceptable exposure occurred among 0.5 percent of rural households—predominantly in the South. Unacceptable gross beta radiation was never encountered in the survey.

While these findings are startling, they must be kept in perspective. The large percentages of rural households with high contamination levels was a function of the level chosen to represent "high"—in this case, the primary MCLs. Again, these levels should not be interpreted as the proportion of households with domestic water exceeding an MCL since no resampling for verification, as required for MCLs, was performed. The levels established as MCLs generally incorporate substantial safety margins. So, even though these levels were identified as "high," and they were higher than was generally expected, they should be evaluated concurrent with the fact that widespread water-related health problems were not apparent throughout the rural US.*

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*The Environmental Protection Agency has participated with other agencies on another national research effort on drinking water quality. The national Health and Nutrition Examination Survey (HANES I) has an augmentation survey of adults aged 25 to 74 years in the United States in 1974-1975. The HANES I study differed from the rural water survey in its purpose, in its statistical sampling plan, in the

Of course, the long term effects of waterborne contamination at currently encountered levels is not known. Even the relatively short-run impairment of health from what it would be without the ingestion of these substances is unclear. Rather than being clear indicators of possible health effects, these high percentages of households with water quality problems, especially coliform bacteria, reflected the marginality of rural water supplies against the backdrop of the primary MCLs mandated for community water systems.

In terms of general water quality, considering all constituents, households in the North Central had the poorest quality water followed by households in the West. Households in the Northeast tended to have the best water quality.

Households served by community systems tended to have the best overall water quality, followed closely by individual systems (usually wells), with those on intermediate systems generally having the poorest quality. Households in SMSA areas and those in large communities tended to have better quality water because they had higher proportions of households on community water systems.

WATER QUANTITY

Relatively few rural households across the US reported a shortage of domestic water. Perhaps because of the essential nature of water, most rural households have made arrangements for adequate quantity, on a regular basis, to satisfy most or all their needs. Moreover, the perception of occupants at most rural households was that their water supplies were ample: about 80 percent reported that the major household supply completely satisfied their water requirements, and another approximately 16 percent reported that it usually or almost always provided sufficient water.

Though most households had adequate quantities of water, a significant number did not. An estimated 700,000 households reported that their supply usually or always provided an insufficient quantity. Most often the insufficiency was attributable to deterioration or inadequate construction of the physical facilities. However, at the extreme, roughly 370,000 rural households hauled water from an off-premises supply, on a regular basis.

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water collection, in the water preservation, and in the laboratory analytical techniques. But some of the contaminants examined were the same. In general, the HANES I Augmentation Study results for metals showed lower concentrations than the rural water survey. Various inquiries into the differences have provided no satisfactory resolution.

The Augmentation Study Survey of adults aged 25 to 74 years in the United States of the national Health and Nutrition Examination Survey I (HANES I) is currently in preparation and will be published jointly by the National Center for Health Statistics and the National Heart, Lung, and Blood Institute.

Among households not connected to community systems, problems of insufficient quantity were more commonly experienced by those supplied by small systems (two through fourteen connections) than by those with their own individual system. Among households with their own supply, those with dug wells more frequently experienced insufficient quantity.

Among rural households connected to a community water system, the median daily household consumption was 664 liters (175 gallons). The median daily per capita consumption was 227 liters (60 gallons).

Consumption of domestic water was not uniform across the US. Western households had a consistently higher consumption pattern than rural households in other regions. No table differences occurred between households located inside and outside SMSAs, or among places of different size.

Among households connected to community systems, locational factors were less important in accounting for variability of consumption than: (1) unit cost (cost per 1,000 gallons); (2) number of people in the household; and (3) number of water-using devices in the household. Although of less importance, the affordability of water and type of ownership of the system were systematically related to variation in consumption. In general, the higher the unit cost, other things constant, the lower the consumption. As would be expected, the greater the number of occupants and the greater the number and usage of water-using devices (dishwashers, washing machines, swamp coolers, as well as toilets and bathing facilities), the greater the consumption. Likewise, the lower the ratio of cost of water to the household's total income, the larger the consumption. Somewhat unexpectedly, households connected to privately owned systems tended to consume approximately 50 percent more water than those connected to publicly owned systems, even after controlling for a number of other, potentially confounding factors.

AVAILABILITY

Most rural households had a readily available domestic water supply. Quantity referred to the usual amount of water. Availability, on the other hand, was defined, for purposes of this study, in terms of two components: (1) the supply's reliability, or uninterrupted service, and (2) the supply's accessibility—one which provided water, under sufficient pressure, when needed and for which the source was not at an inconvenient distance relative to the point-of-use by household occupants.

A total of 5.6 million rural households (roughly 26 percent) experienced water supply breakdowns during the year preceding the interview. Among those households, the majority experienced only one or two interruptions of service. About 15 percent of these households (3.2 million) indicated the breakdowns lasted more than six hours.

In terms of regional differences, household supplies in the South seemed to be somewhat less reliable than in the other regions. Although the reliability of SMSA and nonSMSA supplies was similar, there were differences according to the size of place classification. Generally, households in small rural communities reported supply breakdowns more frequently than households in large rural communities or other rural areas. Similarly, water supply breakdowns which were considered severe—lasting more than six hours—occurred more often among households situated in small rural communities.

Compared with households using individual or community systems, a larger proportion of households served by intermediate systems reported one or more supply breakdowns. In addition, a greater proportion of households served by intermediate systems reported breakdowns that were severe.

Regarding accessibility, sources were generally located at convenient distances from the household. Among rural households connected to community systems, connections involved only piping from the edge of the property to the house, generally a modest distance. Moreover, among households with their own, on-premises supply, over half were located within 10 meters (33 feet) of the house. However, comparatively greater distances were recorded at approximately 15 percent of the households—implying the need for more extensive piping or other mode of conveyance. For the approximately 370,000 households that had to haul water, accessibility imposed a far greater relative hardship.

Supplies were less accessible in the South and West than in the Northeast and North Central. Though accessibility of SMSA and nonSMSA supplies was similar, households located in open country were relatively less accessible than those located in villages.

COST AND AFFORDABILITY

The cost of water was not estimated for rural households using their own supply or for those connected to a system that didn't explicitly charge for water on a regular basis. Assessment of the cost of water was restricted to rural households served by community systems which had a billing system. Perceptions of cost, however, were assessed for all rural households.

Compared to many other consumable items in the US economy, water is inexpensive. The median household monthly cost per thousand gallons was $1.35 nationally. The median total monthly bill for water was $7.00. A ratio of billed cost to total household income (times 100), as a measure of affordability, indicated that three-quarters of all rural households were paying less than 1 percent of their income for water. Across the nation, water was found, at the extremes, to be as inexpensive as $.08 and as expensive as $23.41 per thousand gallons. Occupants in the majority of rural households (79 percent) felt the water was reasonably priced or inexpensive. Domestic water was perceived as expensive or very expensive at about 14 percent of households.

Costs of domestic water were not uniform across the US. Regionally the median cost per thousand gallons ranged from a high $2.00 in the West to $1.33 in the South. Households within SMSAs had lower water costs than those located outside SMSAs. The respective medians were $1.08 and $1.62. Median water costs varied only slightly according to the size of community in which the household was located.

Despite these findings, a greater proportion of rural households in both the South and West felt the water was expensive or very expensive. A greater proportion of residents living within SMSAs reported their water costs were high than was reported by those living outside SMSAs. Likewise, perceived costs tended to rise the larger the size of place.

In addition to locational differences, several other factors were found to be systematically related to household water costs. Regarding the amount billed monthly, the single most important factor was, as expected, the amount of water consumed. After adjusting for this factor, it was still discovered that total monthly costs increased with the number of household occupants, and the education level of the head of the house. Households connected to privately owned systems paid more than those connected to publicly owned systems. On the other hand, the longer the household had been connected to the system, the lower the total monthly cost.

It was found that lower unit costs (price per thousand gallons) were associated with (1) the size of the water system providing the water, (2) the system's source water, and (3) the amount of water consumed at the household. Generally, the larger the system, the lower the unit cost. Systems using ground water usually had lower unit costs, probably due to the lowered treatment and storage costs. Some price break resulted for households with large monthly consumption.

WATER SYSTEMS

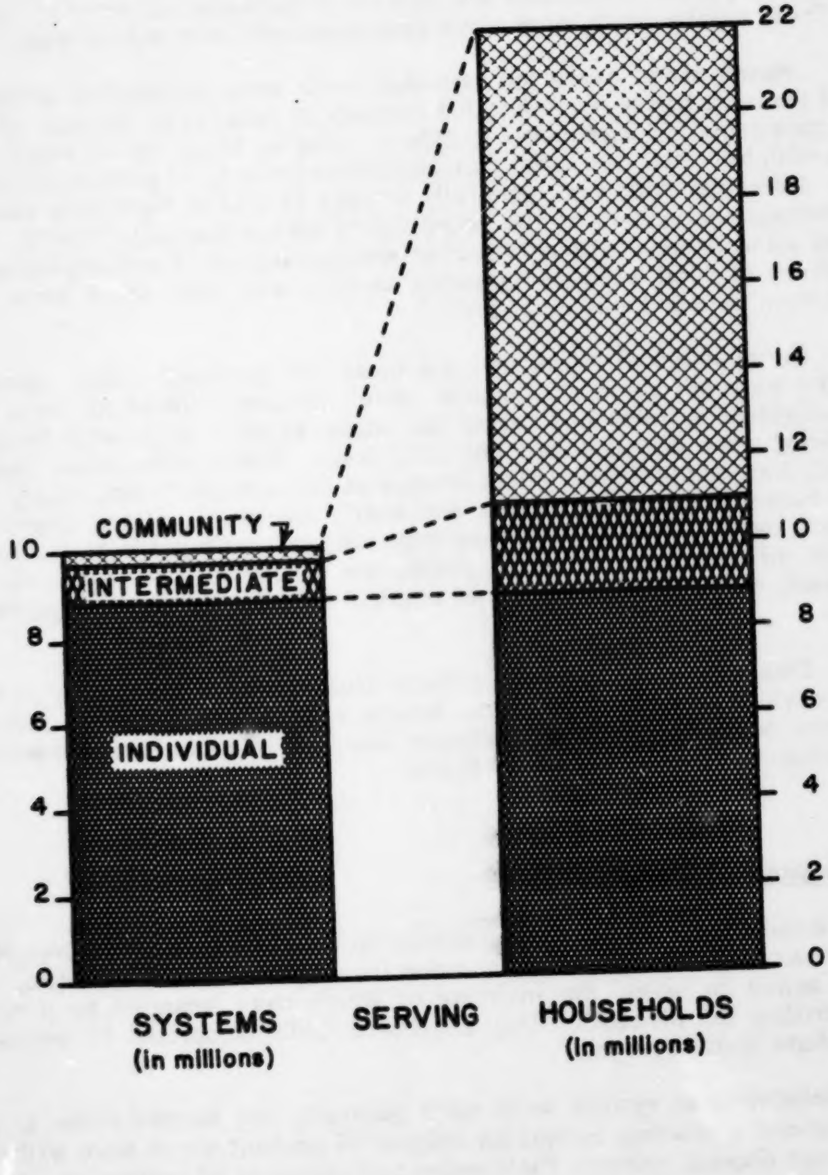
In this study, water systems were examined in order to specify technical, economic, and organizational features associated with delivering water to rural households. Rural water systems were classified according to three major system-size categories: individual systems (single connection), intermediate systems (two through fourteen connections), and community systems (fifteen or more connections). The community systems were further classified as independent (with self sufficient features) versus consolidated systems (with operating or organizational features integrated with other systems or administrative bodies).

Overall, individual systems were by far the most prevalent, numbering 8,765,000. In contrast, there were 845,000 intermediate systems and only 34,000 community systems. Because of this multiple-connection feature, however, intermediate systems and especially community systems were far more important in rural water delivery than implied by their numbers. When taking into account the number of rural households served by each type of system, community systems were most prominent (serving 10,981,000 households), followed by individual systems (serving 8,765,000 households), and intermediate systems (serving 2,228,000 households). See Figure 1.

Community water systems were defined for purposes of the study as those having fifteen or more connections. The standard EPA definition of public water systems is somewhat different. It refers to fifteen or more connection systems used by year-round residents or to systems which regularly provide service to 25 or more year-round residents. The NSA study's definition yielded a count of 34,000 community water systems. Had the study's definition been altered to ten or more

Figure 1

Comparison of Number of Systems and Numbers of Households Served in Rural America



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connections, the count of community water systems serving rural America would have been about 47,200. The latter count is probably much closer to the standard EPA definition.

Individual Systems

Of the 8.8 million individual systems in rural America, 90 percent relied on wells. Other types of supply—surface water, springs, cisterns, hauled and purchased supplies—comprised the balance of individual systems across the country. These supplies were more often associated with poor quality water.

Nearly six of every ten individual wells were installed by drilling, which is one of the more highly recommended methods of installation because of the usually good contamination protection it offers. Dug or bored wells, which were often linked with bacterial contamination, represented nearly 18 percent of all individual wells. Individual wells were generally located 50 feet or more from most potential contamination sources, with the exception of sewage disposal systems. About one-fifth of all wells were within 50 feet of sewage disposal. Field inspection classified 62 percent of rural wells as appearing to have wellheads which were adequately sealed from solid or liquid pollutants.

Bacteriological tests and chemical (or physical) water tests by rural residents were not common. Slightly more than one-third of all rural households with individual systems had tested the water at least once, with bacteriological tests being more frequent than chemical tests. Test results, when they could be recalled, were generally classified broadly as "acceptable." But, nearly 45 percent of the bacteriological test results and nearly two-thirds of the chemical results were not known. This lack of knowledge may be attributable to the respondent's lapse of memory, poor filing practices, the length of time since the test was completed, or may have implied incomplete or uninterpretable reporting of test results.

Treatment practices can in many situations alter the quality of the source water provided to rural households. Among individual systems, the most common treatment device was a water softener (used in 18 percent of systems). Other water treating devices were rarely found.

Intermediate Systems

Intermediate systems were similar to individual systems. Over 90 percent had only two or three connections and less than 2 percent were metered. About 88 percent relied on wells, the majority of which were installed by percussion or rotary drilling (65 percent). Dug and bored wells comprised 17 percent of all intermediate systems wells.

Intermediate system wells were generally not located close to potential sources of contamination, except for roughly 16 percent which were within 50 feet of a sewage disposal system. Field inspection classified 67 percent of intermediate system wells as acceptably sealed against pollutants.

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Water quality tests were performed less frequently among intermediate systems than individual systems. Bacteriological testing had been done at least once during the lifetime of the system at 22 percent of systems. Testing for chemical properties of the water had been done at 10 percent of systems. In contrast to individual systems, among those intermediate systems which tested, owners could usually provide information about the testing history as well as the test results. Of the bacteriological tests performed, over 91 percent showed acceptable counts of bacteriological content. As to treatment practices, among intermediate systems, softening—the most common treatment process—occurred in only 6 percent of the systems.

Information on average daily use and maximum daily (design) capacity collected at water systems provided some indication of the quantity of water provided to rural households connected to those systems. About one-third of intermediate systems had information on production and design capacity. Among those with readings, the median for average daily use was 758 liters, or about 200 gallons. The median design capacity was 44,000 liters (11,600 gallons). The median of the maximum daily design capacity was nearly 60 times the median "average daily usage" level among intermediate systems serving rural households. This difference suggests that some intermediate systems, similar to larger community systems, overbuild to a certain degree, allowing for expansion, fire protection, or increased consumption.

Availability indicators included the number and severity of system breakdowns, and the ease or difficulty in acquiring water from the source. About one-quarter of intermediate systems reported breakdowns of any kind, and few reported any difficulty obtaining water from ground or surface sources. The majority which did report breakdowns had experienced only one or two during an entire year. Despite these favorable findings, a very high proportion of households connected to intermediate systems reported reliability problems in the sense that nearly all breakdowns resulted in a loss of service to water users.

Most intermediate systems did not report revenues or any monetary charging structure for the water service they provided. This fact suggested that water was very cheap for intermediate system customers, but may have also indicated that system owners bear the entire cost of installation, operation and maintenance.

Independent Community Systems

Independent community systems were self-contained systems which secured water from their own sources, treated the water, distributed it, and managed their own organizational and financial affairs. They comprised about 88 percent of the 34,000 community systems in rural America.

Although independent community systems had more extensive extraction, treatment, and conveyance arrangements than intermediate systems, they still were very small in comparison to the larger, more complex systems such as those based in large cities. The median number of connections was 59 and the median length of distribution lines was 1.5 miles. About half of these systems metered their connections. Similar to smaller systems, the predominant source of water was ground water (90 percent). The labor-time demands involved in operation and maintenance of the system were modest, with many requiring two or fewer man-days of labor per month.

Water testing and treatment were much more frequent and extensive at independent community systems than at systems with fewer than fifteen connections. Fully 91 percent had conducted bacteriological tests and about 54 percent had done chemical testing. Treatment equipment was installed at nearly two-thirds of all independent systems. Most independent systems relied on facilities outside their own organizations for performing water quality tests. For the most part, bacteriological tests conducted during the year prior to the study (1977) reportedly met the levels prescribed by regulations affecting the systems. In general, there were too few chemical and physical tests performed to suggest meaningful patterns.

About 63 percent of independent community systems provided average daily usage and design capacity figures. Among those which reported, the median for average daily usage was 136,000 liters (36,000 gallons). The median design capacity was 546,000 liters (144,000 gallons). Maximum daily production capacities among independent systems were four times larger, on the average, than the estimated average daily use. Though this ratio was less than for intermediate systems, it was large enough to accommodate fire protection, increased usage, and increasing the number of connections because of the larger volume being produced daily.

Independent community systems were less reliable than intermediate systems. A larger proportion of independent systems (55 percent, compared to 26 percent) had breakdowns, although fewer resulted in an interruption of service to customers. As was true for intermediate systems, few had difficulties in obtaining water from any source.

Consolidated Community Systems

The consolidated community systems relied on interdependent links with other organizations. One type of consolidated system had a number of separate, individual facilities of which each served one community, but which were jointly owned and administered by a central company. Another type consisted of a facility which purchased water from another organization—a situation which was the distinguishing feature at nearly 90 percent of the consolidated systems.

The consolidated systems tended to be the largest of the systems serving rural America. The median number of connections for the 4,000 consolidated systems was about 153—two and one-half times the median number for independent community systems. Likewise, consolidated systems employed more system operators and metered a larger proportion of all connections.

Testing for water quality was more extensive at consolidated community systems than at independent community systems. Bacteriological testing was done at almost all (98 percent) consolidated systems, and chemical testing was performed at about 90 percent of systems. Results for bacteriological tests were not uniformly interpretable. But, about 96 percent of the systems reporting tests had acceptable results for either the previous twelve tests or for those tests conducted over the last year. The variety of constituents tested, disparities in the age of the tests, and the lack of information on analytic procedures combined to render the chemical testing results uninterpretable.

Similar to independent community systems, consolidated community systems could produce, on the average, over four times the quantity of water that was consumed on a daily basis. The median for average daily use was 162,000 liters (43,000 gallons) among the 88 percent of consolidated systems which had the information. Design capacity was obtained for half of the consolidated systems. The median design capacity was 719,000 liters (190,000 gallons).

About 50 percent of consolidated systems had breakdowns during the year preceding the study. This proportion was slightly smaller than for independent systems (55 percent), but still considerably greater than for intermediate systems (26 percent). This finding could be interpreted to mean that problems of reliability were more often associated with larger, more complex systems. However, it was also the case that these larger systems more frequently had alternatives in the event of some malfunctions (such as auxiliary pumps, storage capacity sufficient to cover demand during a breakdown, and so forth).

CONCLUSIONS

1. Most rural households had a domestic water supply which was acceptable by most of the quality indicators used, was in sufficient quantity to meet consumption demands, was readily available on a continuous basis, had a reasonable cost, and was affordable. But, the exceptions were not rare and the difficulties were not always minor.

2. The overwhelming majority of rural households had water judged to be of acceptable quality for any particular characteristic studied. But, almost two-thirds of all rural households had water judged unacceptable for at least one of the constituents which have been given primary MCLs (excluding turbidity). Bacterial contamination, in particular, was the predominant problem encountered.

3. The quality of the water available in most rural households was due to numerous factors, but a few can be highlighted. Most rural households (on the order of 90 percent) relied on ground water. High quality well technology and well construction practices were generally evident throughout rural America. Their employment apparently helped minimize alteration of the water from the quality it had at the source until it was delivered to the tap.

4. Larger, more frequently monitored community water systems generally delivered water of higher quality than smaller and less frequently monitored systems.

5. By comparison with community systems, individual and intermediate systems employed less complex technologies and less frequently used water treatment devices. Therefore the quality of the water delivered to the household was mainly a reflection of the quality of the source water (which was ground water for 90 percent of these systems). As long as the fundamental quality of the ground water source remains intact, further improvements in well technology and construction practices would beneficially affect the quality of delivered water by ensuring the protection of the quality from source to tap. A larger benefit would probably result from presently deficient wells being replaced or brought up to current standards of good practice for well construction. Direct regulation of small (usually individual) water systems would probably not dramatically alter water quality because of the common lack of treatment devices and the improbability of their installation due to the relatively large capital costs for the individuals involved.

Therefore, perhaps the greatest protection for the continuing quality of water from noncommunity water systems would be the preservation of ground water quality, particularly the freedom from bacterial contamination. Acceptable well construction practices for households using individual and intermediate wells appeared to reduce bacterial contamination potential. Proper siting of wastewater disposal, or wastewater removal by public sewer systems were also associated with lower bacterial contamination for households served by individual systems. Additional improvement in water quality among water systems with fewer than fifteen connections might result from wider availability of water testing services and public education on their availability, their importance, and on possible response alternatives to identified problems.

6. The more extreme the rural householder's evaluation of the water supply, whether good or bad, the better was the correspondence with the composite indicators of laboratory-measured quality. Households which were very positive about their supply usually rated well on the laboratory measures. Households in which the water supply was given a poor rating also tended to have laboratory-measured deficiencies.

Responses to questions regarding the relative cost of the supply and the respondent's willingness to pay more for an improved supply were both useful indicators of the quality as measured by the laboratories. In general, households reporting low relative costs or strong willingness to pay more for an improved supply, tended to have poor water quality according to composites of laboratory measures. Households which reported their supply was expensive or where the respondents lacked a willingness to pay more for an improved supply tended to have superior quality water according to the laboratory indicators.

7. It was noted that average daily consumption of water was greatest in the West. This was so even though the unit cost of water was highest in the West. Rural households of the West generally relied upon their major household supply—usually a community water system—for virtually every water need around the home, yard, and garden.

Over the last fifty years or so, there has been a federal subsidization of Western water through low interest construction loans on large scale reclamation projects. Water cost comparisons among large Northeastern cities and large Western cities have frequently resulted in the observation that Western cities often charged far less for domestic water than those in the Northeast. That effect was not borne out by the NSA for systems serving rural Westerners. Most of the community water systems in the West were relatively small and they were charging on the average the highest rates among systems serving rural America. (Possibly, there is an important economy of scale related to the acquisition and transport of the water. Large systems are more likely to be primary customers, that is, to have a direct arrangement in terms of payment and piping with large scale reclamation projects. Smaller systems, on the other hand, may end up being secondary customers which buy from large systems at some higher price. But even when a small system obtains its water directly from a large scale reclamation project, or from a smaller local project, or from a deep well, the relative cost per connection would generally be higher than that experienced by large systems. Thus, even with the federal subsidization of much of the developed water in the West, the average unit cost for water among rural Western households was higher than for other rural parts of the country.)

8. Intermediate systems were found to provide generally inferior service compared to community and individual systems. It is suspected the reasons for this lay with the nature of the design.

Apparently most of these small systems were not originally designed or intended to be integrated, multiple-connection systems, but were originally installed as individual systems to which additional households were later connected. For instance, a relative, hired hand, or friend could build a home adjacent to a house with an existing individual supply. Because of the cost of installing a new system, occupants of the new household might ask, or be invited, to hook up to the existing well rather than install a separate facility. It appeared that many small intermediate systems seem to have started as individual systems and evolved to become two and three connection systems without any accompanying redesign. Many of these extended connections were probably homeowner installed.

The result of these extensions and modifications to the original system is a strain on the capacity of the system. These apparently stressed systems provided, as a group, the poorest overall service of any system configuration studied. A higher proportion of households connected to intermediate systems experienced problems with water quality, they more frequently had insufficient quantity, and they tended to report a greater number of breakdowns.

The trend in many parts of the country toward falling ground water levels and increasing well construction costs may increase the likelihood of more rural households entering into multiple connection arrangements on individual systems not designed for that purpose.

* * *

This executive summary captures in only the broadest form the detail of the full, 1,900 page, report. The five volume document describes attributes of rural water users, households, supplies, and systems as they related to the quality, quantity, availability, and cost of rural domestic water conditions. Each topic is explored for the nation as well as for various subnational categorizations. The study is a one-time effort which strives to be comprehensive, rather than exhaustive on any particular topic. The report is the first systematic, nationally representative examination of the broad issues related to rural domestic water.

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Preface

This report presents the findings of a national research survey of rural household water conditions. The purpose of the study, which was mandated by Congress in the Safe Drinking Water Act of 1974, was to gather information about the quantity, quality, availability, and cost of water supplies in rural America.

Under the direction of the US Environmental Protection Agency (EPA), extensive developmental work was done in preparation for the survey, including specialized studies on particular aspects of rural water supply. These efforts laid the groundwork for what became the major thrust of the rural water survey: the National Statistical Assessment of Rural Water Conditions (NSA). The NSA was the first systematic national study of rural household water supplies. It was designed as a comprehensive sampling of rural households so that it would accurately reflect the full spectrum of rural domestic water conditions. Supplies using any of three basic sources of water—groundwater, surface water, and precipitation—were represented in the survey, as were all sizes of water supply systems—individual supply systems which served a single household, intermediate systems (defined in the NSA as any multiple-connection arrangement which served from two through fourteen connections), and community systems of various sizes.

The NSA studied the physical and technical components of water supplies and performed a laboratory water quality analysis on specimens of each household's major water supply. In addition, through interviews at households and at supply systems, the NSA looked at the social framework that surrounds every rural household's water supply—the perceptions and attitudes of those who use the water, the personal economics of securing a water supply, and the financing of intermediate and community systems. The outcome of all this work is an integrated picture of rural household water conditions in the continental United States.

The NSA used an elaborate sampling scheme to ensure that its data would be representative of the diverse situations that existed in various parts of the country. It gathered data from every state except Alaska, Hawaii, and Wyoming. Alaska and Hawaii were purposely excluded because their unique characteristics would have interfered with generalizations to the rest of the United States. Since the sample was drawn in proportion to rural population, the low population of Wyoming precluded any of its counties from being selected for study. A total of 2,654 households were interviewed and studied; this sample was representative of the roughly 22 million households in rural areas of the US in 1978. Data collection took place from May 1978 through January 1979.

This document and its attachments comprise the final report of the NSA and the rural water survey. The report presents the results of the NSA and incorporates findings from certain associated investigations that were done in conjunction with the rural water survey. The authors have attempted to provide a readable yet thorough and technically complete report of the massive survey research effort.

The detailed findings constitute a sourcebook of information on many aspects of rural households and rural water supply. Because of the size of the report, however, descriptive and analytical findings are summarized in Chapter I.

This technical summary may be useful to some readers as an overview of NSA results.

The NSA used a multidisciplinary approach to describing and analyzing rural household water conditions. It is hoped that this report will be a useful reference document for many readers in the various disciplines, and that it will serve as groundwork for further research and informed policy on rural water supply.

Acknowledgments

Early planning of the NSA was done by a special research group in the Department of Rural Sociology at Cornell University in consultation with EPA staff and an advisory committee from the National Demonstration Water Project, a Washington-based nonprofit organization concerned with the provision of adequate, affordable water and wastewater disposal services to the rural poor. As an ancillary activity of the rural water survey, NDWP also commissioned several studies on discrete topics dealing with rural water supply.

The Cornell research group, in concert with the Office of Drinking Water, EPA, developed the conceptual framework of the NSA, designed the survey, and constructed the interview schedule, which underwent extensive pretesting before use. The Cornell group was aided in this effort by sanitary engineers, microbiologists, and water chemists from the EPA staff; consultants on water systems technology from Engineering Enterprises, Inc., of Norman, Oklahoma; and several social scientists from various universities. The Cornell researchers also received valuable planning assistance from the Conference of State Sanitary Engineers, the University Council on Water Resources, and the National Water Well Association. Cornell did not perform the data collection itself. Instead, it took an advisory role in both the data collection, which was done by TransCentury Corporation of Washington, DC, and in the design of the sample, which was drawn by Survey Design, Inc., a subcontractor of TransCentury. As part of its advisory capacity, the Cornell research staff supervised and monitored the field work, coding, and computerized data storage. The Cornell research group conducted all phases of the data analysis and compiled the final report.

Several laboratory groups and organizations were involved in the analysis of bacteriological, chemical, radiological, and physical properties of the drinking water samples collected at each household. Under subcontract with TransCentury to conduct the bacteriological assays were Energy Resources Company, a private laboratory organization which was assigned the lead role and worked in cooperation with the Madison County Environmental Control Department and the Colorado State Health Department. Under a separate contractual arrangement with the EPA Office of Drinking Water, analysis for the presence of herbicides and pesticides was conducted by laboratories at the Medical University of South Carolina and the Mississippi State Chemical Laboratory. The assays of chemical and physical properties were conducted by the EPA-Municipal Environmental Research Laboratory in Cincinnati and EPA-Environmental Monitoring and Support Laboratory in Las Vegas. The latter organization also conducted all the radiological assays. All results from these laboratories were transmitted to TransCentury which, in turn, transmitted them to Cornell.

In compiling the quality assurance report on the work at these laboratories, several individuals from the Technical Support Group of the EPA Office of Drinking Water were most helpful. Special thanks to Lowell VanDenBerg and Carl Hirth from that group.

Throughout all phases of the NSA, Cornell and the EPA worked together closely. To give further assurance that the NSA would adequately address the needs of the many interested parties, a review panel was brought together to assess the data analysis efforts. Its recommendations on reporting the research results were of critical importance in the final phase of the study and led to an improved, more readable report.

The review team, selected by EPA, consisted of Martin Allen, Hugh Holman, Arnold M. Kuzmack, Richard Raines, Phillip Tate, and Wilbur Whitsell, all of EPA; Joseph Delfino, University of Wisconsin - Madison; James Edzwald, Clarkson College of Technology; John Hernandez, New Mexico State University at Las Cruces;[1] Tyler E. Gass, Bennett and Gass, Inc.;[2] Harvey Johnson, Mississippi Institute for Small Towns; George Klumb, Culligan International Co.; Robert L. Lawrence, Director of Public Utilities, City of Alexandria, Louisiana;[3] William N. Long, a private consultant on sanitary engineering from Boulder, Colorado; Robert Murphy, National Center for Health Statistics; David L. Rogers, Colorado State University; and Glenn Walden and Gary Morgan, Farmers Home Administration.

Special thanks to Phillip L. Tate of the Office of Drinking Water, EPA, whose managerial skill and personal tact guided the study through its many difficult phases.

The Cornell staff is indebted to several colleagues for their helpful advice and consultation. David Allee, Norman Dondero, and Don Gates helped us through many difficult analysis and reporting dilemmas. Dave Ingersoll and Ramish Vaidya provided valuable help with the economics of water supply. Todd Quinlan was indispensable to the training and monitoring of interviewers, editors, and coders.

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[1] On March 19, 1981, Dr. Hernandez tendered his resignation from the review team, as he became a Presidential designee for the position of Deputy Administrator of EPA, to which he was confirmed May 6, 1981.

[2] Formerly Director of Technical Services, National Water Well Association.

[3] Formerly Director of Louisiana Rural Water Association.

Thanks to Betty Van Amburg and Janet Stauderman for valuable aid in composing the report through its many drafts on the word processor and for painstaking proofreading.

Though the Cornell staff is grateful to all of these individuals and organizations which contributed to the enhancement of this important document, ultimate responsibility for its accuracy and integrity resides with the Cornell research group.

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I

Technical Summary

As explained in the Preface, topics in this study range from domestic water conditions in rural households to economic conditions at water systems serving the households. This information is kept in perspective by reference to demographic data regarding rural households. The voluminous details of the study are organized in a systematic plan which is described in the Preface and in Chapter II. The purpose of this chapter is to condense the findings in order to provide a concise overview. The reader is cautioned, however, that the intent of the overview is to provide orientation to a vast amount of data. Of necessity, the focus is only on the salient aspects of the study. Thus, the reader should avoid making definitive judgments about NSA findings on the basis of this summary alone. Conclusions should be based on careful readings of the text, where the NSA findings are amplified, qualified, and fully explained.

The major findings in each chapter in turn are presented in this summary. The sequence in which the findings are given is not necessarily that used in the respective chapters, however. The sequence sometimes is altered in this chapter to facilitate comparisons and to aid readability, but the reader generally is advised if this is done.

SUMMARY OF CHAPTER II

The formal introduction to the NSA is provided in Chapter II. The introduction traces the development of the study: its scope, uniqueness among other studies about domestic water conditions, specific terminology, objectives, sampling and data collection methodology, and its analytical structure. Here, the focus is limited to aspects of terminology, methodology, and analytic procedure which are of importance in understanding this summary.

As to terminology, certain terms which have broad connotations in other studies were defined more narrowly in the NSA. It was necessary to separate source from water supply. "Source" was defined as any physical aggregation of water prior to human manipulation. "Water supply" in the NSA was defined as the set of facilities by which water was extracted from the source, treated, and transported to the household—or as the water itself as it reached the household. "System" referred to the social and organizational aspects of water supply, and was represented by three specific types: individual systems, which served a single household; intermediate systems, which had from two through fourteen connections; and community systems, which had fifteen or more connections (roughly corresponding to community systems affected by federal drinking water regulations). The community systems were further classified as either "independent" (generally self-sufficient) or "consolidated" (relying on certain interdependent links with other organizations).

It also was necessary in the NSA to distinguish between a household's drinking water supply and its major water supply. The drinking water supply was that one used exclusively for drinking, while the major supply was defined as that one which satisfied most of the household needs (whether it was used for drinking or not). In fact, it was discovered that in most rural households (about 97 percent) the major supply and the drinking water supply were the same, but the distinction was important for analytic reasons described in Chapter II. It also was necessary in the NSA to develop specialized connotations for six major aspects of water conditions—quantity, quality, availability, potential health hazards, cost, and affordability. Those connotations will be mentioned as needed in this summary, but the full discussion of their meaning in the NSA is presented in Chapter II.

The results presented were for two types of entities: rural households and supply systems. Some results pertained to rural households, the occupants, and the status of the water they used. Other results pertained to the systems which provide water to these households. For purposes of this study, rural households were defined as those located in places less than 2,500 population or in open country.

Approximately 2,600 rural households were selected by a carefully controlled stratified, proportionate probability sampling design. These households and the approximately 1,100 systems providing their water underwent intense observations and were the basis for all findings presented.

As to the NSA analytic procedure, findings were assessed first, for the national as a whole. The findings then were assessed, as appropriate, according to four subnational groupings. The first subnational grouping was by four regions as determined by the US Bureau of the Census (Northeast, North Central, South, West). The second grouping was by SMSA areas versus areas outside of SMSAs. The third grouping was by size-of-place: large rural communities (places where the population was 1,000 through 2,499); small rural communities (places where the population was 999 or less); or other rural areas. The fourth grouping was by size of system (individual, intermediate, and community, as described above). The last four chapters present systematic relationships between each of the major dimensions of rural water supply considered in this study and selected attributes of the household, its supply, and system.

SUMMARY OF CHAPTER III

The rural household was the focal point for the collection of data in the NSA and the terminal point for domestic water usage. Because of this, it was important to develop a clear picture of the general socioeconomic conditions in rural households, the nature of rural domestic water use, the types and number of water-using appliances, and the residents' general attitudes toward the water supplies. This information, presented in Chapter III, provided the framework for evaluation of the NSA results.

Another key aspect of the NSA report which is described in detail in Chapter III, and analyzed systematically in Appendix B, is the use of projected data for all rural households in the US. As is necessary in this type of national survey, the projections in the NSA were made on the basis of investigations at a scientifically selected sampling of rural households. Based on projections from the NSA sample, it was estimated that at the survey's midpoint (September 1978), there were approximately 21,974,000 occupied housing units in rural America.

About 31 percent of Americans lived in rural households in 1978. Rural households in the US were located predominately in the South and North Central: 42.3 percent of the households were in the South, 28.3 percent in the North Central. Classified in a different way, 68.0 percent of rural households were located outside of SMSAs, 32.0 percent within SMSAs. Consistent with the large proportion of households outside of SMSAs, about 83 percent of households were located in other rural areas, as opposed to much smaller proportions in large and small rural communities.

DEMOGRAPHIC PROFILE OF RURAL US

Summarized first are data about structural and occupancy characteristics of rural dwelling units. Presented next is demographic information about the head of household and about household members.

As to types of housing, the overwhelming majority of rural households (about 81 percent) were in single-family, conventional homes. About 12 percent of the households were in single-family mobile homes. The rest were in multi-dwelling unit structures.

The highest proportion of single-family housing units (86.2 percent) was in the North Central, the lowest (77.0 percent) in the West. In contrast, the South had the largest proportion of mobile homes or trailers (16.3 percent), whereas the Northeast had the smallest proportion (5.7 percent) of mobile dwellings.

As to ownership of the households, about 79 percent were owner-occupied, about 18 percent were renter-occupied, and the rest were occupied by people who had other arrangements—e.g., provided by parents, occupied rent free. Ownership arrangements involving farms associated with rural households also were studied in the NSA. Accordingly, about 3.7 million (about 17 percent of rural households) owned or leased farms, which were numerically most prevalent in the South and North Central. However, of the 3.7 million households which owned or leased a farm, 960,000 had no income from sale of farm products.

Regarding length of residence at the households, median length of residence for heads of rural households was 5.2 years nationally. Regionally, the median was shortest in the West (3.8 years), reflecting the general pattern of recent migration to the Western states. In contrast, median length of residence was greatest (6.3 years) in the Northeast. In SMSA households, the median length of residence was 4.1 years, compared to 5.9 years in nonSMSA households.

As to the number of people in rural households, the NSA findings did not support the traditional assumption that rural families are large. In fact, nearly half of all rural households had only one or two members; the median number of households occupants was 2.65.

For the most part, men were reported to be the heads of rural households. On the other hand, women were designated heads in 18.7 percent of rural households, a 3.8 percent increase since the 1970 census.

The household heads were predominantly white—only 8.7 percent, or 1.9 million, were nonwhite. Their median age was 44 years, five years younger than the median age at the time of the 1970 census. The household heads had completed a median of twelve years of education, indicating a trend toward increased education since 1970. Only 2.8 percent of household heads were unemployed (70.5 percent were working full or part time the week before the NSA interview, 21.1 percent were retired, and 5.5 percent were in some other employment category). In 1978, the Northeast had the highest proportion of rural heads working full or part time (78.9 percent) and the West had the lowest (66.9 percent). Rural households in SMSAs had a higher proportion employed (78.8 percent) than nonSMSAs (66.7 percent).

Of the approximately 15.8 million working household heads, about one-third were employed in professional, technical, managerial, or administrative occupations (excluding farming). Another 20 percent were in crafts or related occupations. Only 7.3 percent described themselves as farmers or farm managers, and only 1.3 percent said they were farm laborers or foremen.

The income available to rural households as a result of a nonfarm occupation or farming may have had an influence on the chosen means for providing basic needs like drinking water. Therefore, NSA analysts attempted to determine total combined income of everyone in the household from nonfarm sources. In addition, for those households that also owned or leased a farm, gross farm income (sales) and net farm income also were tabulated. However, evaluation of the household income—particularly farm income—involved qualifications which are beyond the scope of this summary. Here, the focus is limited to a brief summary of the findings for total household income and for household nonfarm income. Thus, the median total household income for rural households during the year preceding the NSA was $12,818—lower than the median for the US as a whole in 1978 ($13,512). Median nonfarm income was $12,676. Regional, SMSA versus nonSMSA, and size-of-place differences were similar for total household income and nonfarm income, and the data for nonfarm income are cited here for convenience. The subnational differences sometimes were prominent. For example, median nonfarm income was greatest in the Northeast and West (about $15,000 in these regions), smallest in the South and North Central (about $12,000 in these regions). Median nonfarm income was $18,000 in SMSA households, compared to $12,000 in nonSMSA households. Median nonfarm income for households in other rural areas was $14,000, compared to $10,001 for households in large communities, and to $10,995 for households in small communities.

PROFILE OF USES OF WATER

Shifting now from demographic data to patterns of household water use, NSA data showed that almost all rural households (about 97 percent) used their major water supply for drinking. Five other indoor uses of the major water supply (cooking, bathing, flushing toilets, washing clothes, and washing dishes) were reported by at least 90 percent of all rural households (each household did not necessarily report all uses), but other indoor uses (such as evaporative cooling) were uncommon. Among outdoor uses of the major supply, the most significant were periodic cleaning (of windows and cars, for example), reported by 80.6 percent of rural households; watering lawns and gardens (66.2 percent); water livestock (12.0 percent); and recreational uses (7.6 percent).

In contrast to indoor major-supply use, outdoor uses showed substantial regional variation, with households in the West reporting a variety of outdoor uses much more frequently than households in other regions. In the SMSA/nonSMSA comparison, SMSA households, more frequently than nonSMSA households, reported two uses—watering lawns and gardens and recreational use. In the size-of-place comparison, only one outdoor use showed appreciable variation—watering livestock, which was reported almost exclusively by households in other rural areas. Two uses—watering lawns and gardens, and periodic outdoor cleaning—were reported most often by households served by community systems and least often by households served by intermediate systems. Having no outdoor uses for the major water supply also was most common among households served by intermediate systems.

WATER-USING EQUIPMENT AND WASTEWATER SYSTEMS

Closely related to household uses of water are the use of certain water-using fixtures and of wastewater systems. About 95 percent of all rural households in the US had complete plumbing facilities as defined by the US Bureau of Census (piped hot and cold water, flush toilet, and bathtub or shower). However, the regional proportions of complete facilities varied from 98.8 percent in the West to 91.5 percent in the South.

In a more specific tabulation of water-using fixtures and devices, it was found that at least 95 percent of all rural households had all of the five most important fixtures: kitchen sink, bathing facility, flush toilet, bathroom sink, water heater, or shared access to such facilities. As with the data on completeness of plumbing facilities, these data showed substantial regional variation. In general, the West's rural households were the most completely equipped, and the South's rural households least completely equipped.

With regard to wastewater systems, almost two-thirds of rural households used either a septic tank, cesspool, or similar arrangement for disposal of wastewater, while about 28 percent were connected to public sewer systems. Direct discharges of wastewater were made at about 6 percent of rural households.

The West had the greatest proportion of households using public sewer systems (42.7 percent), and the smallest proportions of septic tank and similar arrangements (55.2 percent) and direct discharges (1.5 percent). The Northeast had the greatest proportion of rural households using septic tanks and the like (74.7 percent), and the smallest proportion using public sewer systems (22.6 percent). Direct discharges were most common in the South, occurring at 9.7 percent of rural households—more than double the proportion in any other region.

Only 23.1 percent of nonSMSA households used public sewer systems, compared to 39.3 percent of SMSA households. Conversely, 67.4 percent of nonSMSA households used septic tanks, cesspools, and the like, compared to 57.6 percent within SMSAs. Direct discharges were far more common among nonSMSA households (8.2 percent, compared to only 1.6 percent of SMSA households).

The size-of-place comparison showed quite different patterns of wastewater disposal. Public sewer systems were used by 71.9 percent of households in large communities, 50.0 percent in small communities, but by only 20.8 percent in other rural areas. Septic tank and similar arrangements revealed almost the opposite pattern being used in 25.8 percent of households in large communities, 44.0 percent of households in small communities, and 70.9 percent of households in other rural areas. Direct discharges, very infrequent in large rural communities, occurred at 4.8 percent of households in small rural communities and 6.1 percent of households in other rural areas.

About 87 percent of households served by individual or intermediate water supply systems used septic tanks or cesspool arrangements. More than half of the households served by community systems (54.3 percent) used public sewer systems, while 41.5 percent used septic tank arrangements. Direct discharges occurred at 9.0 percent of households served by individual water supply systems, compared to

6.4 percent of those using intermediate systems and 2.5 percent using community water supply systems.

Reliability of the wastewater systems was assessed in the NSA according to household experience with breakdowns. Breakdowns in wastewater systems had occurred in the year prior to the NSA at 6.1 percent of all rural households in the US (1.3 million). For the most part, the breakdowns were limited to only one or two occurrences. At 4.3 percent of all rural households, the breakdown was severe in that it lasted for six hours or longer. At nearly two-thirds of the households with breakdowns, the incidents involved septic tanks or similar arrangements; breakdowns at about one-quarter of households involved toilets, pipes, or related equipment; breakdowns at 7.4 percent of the rural households were associated with public sewer facilities.

ATTITUDES TOWARD WATER SUPPLIES

The final section of Chapter III describes household attitudes toward water supplies. Specifically, the NSA asked a series of questions about liked and disliked supply characteristics, respondents' general satisfaction with their water supplies, and possible preferences for changing to a different supply.

About two-thirds of respondents identified a specific characteristic of the water supply which they liked—most often, taste. About 44 percent identified a specific characteristic which they disliked—again, taste was mentioned frequently, along with hardness. Regional variation was not striking, though temperature was mentioned as a liked characteristic most often in the West (14.8 percent) and least often in the South (5.6 percent). Hardness was disliked at about 18 percent of rural households in both the North Central and West, compared to 5.0 percent of households in the South.

In the size-of-place comparison, the water supply's taste was liked far more often at households in small rural communities and other rural areas than at households in large rural communities. The temperature was liked far more often in other rural areas than in large or small communities.

The size-of-system comparison showed greater variation than occurred in the other subnational categories. Specifically—in comparison to households served by individual or intermediate systems—a much smaller proportion of households served by community water systems liked the water's taste (21.5 percent) and temperature (4.4 percent), though a much larger proportion liked the supply's reliability (11.0 percent). Conversely, taste was mentioned as a disagreeable characteristic more than twice as frequently among households served by community systems (13.8 percent). Hardness was mentioned as a disagreeable characteristic most often among individual-system households (15.3 percent).

When respondents were asked to rate their current water supply against an ideal supply, 72 percent reported their present supply to be essentially equal to the idealized supply. However, in over five million households (23.9 percent), the ideal supply was rated superior to the existing one, while the remaining 4.1 percent (900,000 households) rated their present supply superior to the idealized one. The proportion of households rating their present supply equal to the ideal one varied substantially from region to region, with the largest proportion so rating their system in the North Central (76.2 percent), and the lowest proportion in the West (68.9 percent). Correspondingly, there was regional variation in the proportion of rural households rating the idealized supply superior, which ranged from a low of 20 percent in the North Central to a high of 27 percent in the West.

Over four-fifths of the rural households preferred to continue receiving water from their present system. However, almost four million rural households (17.8 percent) stated a preference for changing to a different water system, most often because of the existing supply's taste. About 46 percent of those desiring a change stated a preference for a community system, and 40.0 percent stated a preference for an individual system. The form of ownership that was preferred was consistent with size preferences. Over 90 percent of the households which preferred changing to an individual water system also preferred having an in-house ownership of the system. At households indicating a preference for a community system, preferences were for public ownership (72.6 percent), cooperative ownership (13.6 percent), and ownership by a private firm (9.2 percent).

Preferences for staying with their present water system were most dominant in the North Central (86.3 percent) and least dominant in the West (77.4 percent). Conversely, preferences for changing to a different water system were reported most commonly in the West (22.6 percent) and least commonly in the North Central (13.6 percent). Though taste was everywhere the most prominent factor in the desire for a change, it was cited far more frequently in the West (36.6 percent). Other leading factors in the West were the softness and healthfulness of the water supply. In the Northeast, reliability and healthfulness were the most frequently mentioned reasons; and in the South, they were convenience, healthfulness, and quantity.

A community system was the most frequently preferred size of alternative system in all regions (preferred by approximately 47 percent) except the Northeast with about 43 percent. There, individual systems were preferred most frequently (by about half). Ownership preferences varied substantially from region to region, with cooperative ownership being mentioned far more frequently in the West than in any other region.

Among nonSMSA households, the most important factors for those households desiring a change were convenience, reliability, and the quantity afforded by the supply, while taste and softness were mentioned more often by SMSA households than by nonSMSA households. As to ownership preferences, cooperative ownership and ownership by a private firm were preferred much more often among SMSA households than among nonSMSA households.

SUMMARY OF CHAPTER IV

Although a central objective of the NSA was to investigate various aspects of drinking water supplies, it became apparent that a study of drinking water supplies in isolation from supplies that served other domestic needs would be inadequate. For example, health and economic issues were involved in the use of water for cooking, bathing, and cleaning as well as in the use of water for drinking. Furthermore, an exclusive research focus on drinking water supplies would not reveal why major water supplies—those used for most domestic needs—were not necessarily always used for drinking. In view of these considerations, the NSA research was focused on aspects of the major water supply, although data also were collected on the types of drinking water supplies in rural households.

Chapter IV is organized so that information about drinking water supplies is presented first, information about major household supplies second. Separate consideration then is given to households which do not use the major supply for drinking, and to households which have supplementary supplies. Finally, the types of water sources are enumerated. In this summary, however, the situation for major supplies is addressed first since that information is the basis for analysis in subsequent chapters. The situation for drinking water supplies is taken up second, and that is followed by a summary of types of water sources.

As to the typology used in the NSA, characterizing supplies in terms of their physical arrangements resulted in seven supply types: (1) multiple-connection system which served fifteen or more households or more than 25 people (synonymous with "community supplies" or "community systems" in the NSA report), (2) wells, (3) springs, (4) surface water (pond, lake, river, or stream), (5) cisterns, (6) hauled water, and (7) purchased bottled water.

As to classification of sources, the NSA centered on conditions at the rural household, and there was no provision for geological assessment of the source of household water supplies. However, on the basis of questions asked of household respondents and of representatives of multiple-connection systems, supplemented by examination of household premises by the interviewers, NSA investigators were able to classify most sources accurately. In addition to the three conventional classifications—groundwater, surface water, or precipitation—three others were included in the NSA for purposes of analysis: "purchased," which designated water which a multiple-connection system had obtained from another supplier (which included purchased bottled water); "mixed," which designated water from a combination of sources (such as groundwater and surface water); and "residual," which designated all water supplies for which the source could not be determined.

MAJOR HOUSEHOLD WATER SUPPLIES

Although the NSA distinguished between the major water supply and the drinking water supply (see Chapter II), the two actually were the same in about 97 percent of rural households. In other words, drinking water was obtained from a supply which was not the major household supply in only about 3 percent (676,000) of all rural households. In all of the other households (21,298,000), drinking water was obtained from the same supply (the major household supply) which served other domestic needs.

As to the type of supply, the major water supply most often was a community supply, particularly in the West, in SMSAs, and in large and small rural communities. Whereas the major supplies were wells in 44.8 percent of systems nationally, wells were the dominant major supply for 60.7 percent of households in the North Central—compared to only 29.1 percent of households in the West. Wells were also the most common major supply for households located outside of SMSAs (about 48 percent) and in other rural areas (approximately 52 percent).

Together, community supplies and wells account for approximately 95 percent (20,831,000 households) of the water supplies of rural households nationally, and subnational variations from this condition ranged from a low of 92.6 to a high of 99.0 percent. Clearly, community supplies and wells are the overwhelmingly dominant types of major household water supplies in rural America.

Regarding the remaining types of major household supplies, springs provided the major supplies for 2.2 percent of households nationally, and surface water provided the supplies for only 0.6 percent of households. Cisterns provided the supplies for 0.6 percent of households, hauled water for 1.2 percent of households, and purchased bottled water for 0.5 percent of households. Although hauled water was the major supply for only about 269,000 rural households, and purchased bottled water (which was sold by a commercial distributor either in small containers or in bulk) was the major supply at only 102,000 rural households, these situations represented potential hardship since most of the households apparently did not have access to a satisfactory alternative.

DRINKING WATER SUPPLIES

Although it was anticipated that many rural households might have more than one drinking water supply, 97.8 percent of the households had only one supply. Moreover, though the NSA distinguished between the household's major and drinking water supply, they were the same for 97 percent of the households. Because of this, the data for drinking water supplies were similar to those for major supplies. Thus, the most common type of drinking water supply (in nearly half of rural households) was a community system. The next most common type (in 43.6 percent of rural households) was a well. Far less common supply types were purchased bottled water, springs, surface water, cisterns, and hauled water—which, taken collectively, supplied drinking water to less than 10 percent of rural households. One prominent aspect of these findings was the prevalence of community supplies in comparison to wells, a reversal of the pattern observed prior to 1975. Possible reasons for this trend are presented in Chapter IV. Parallel to the pattern for major household supplies, wells and community supplies together account for 93.0 percent of the drinking water supplies.

As to findings in subnational classifications, community supplies for drinking were most common in Western households (61.6 percent), least common in North Central households (36.8 percent). Conversely, well supplies were most common in North Central households (59.0 percent), least common in Western households (27.8 percent). Within SMSAs, community supplies were used at about 58 percent of rural households, compared to about 45 percent of households outside of SMSAs. (Outside SMSAs, 46.7 percent used wells.) In large rural communities, 91.8 percent of households used a community supply for drinking water, as did 80.4 percent of households in small rural communities. In other rural areas, however, 41.0 percent of households used community supplies, and 50.8 percent used wells.

As to the scope of potential problems at households with hauled or purchased bottled drinking water supplies, the most common reason for having either type of supply was that other types of supplies at the households did not provide water of sufficient quality to drink. Among the 733,000 households with at least one hauled drinking water supply the median quantity of water hauled each month was 228 liters (60 gallons). Among the 545,000 households with at least one purchased bottled water supply for drinking, the median number of times that water was purchased was about 3.3 times each month. Purchased bottled water was bought from a grocery store for the majority of households, and 20 liters (five gallons) or less at a time was purchased for about 54 percent of the households. The median quantity of water purchased each month was about 64 liters (seventeen gallons).

Although most rural households had only one drinking water supply, 2.2 percent (about 494,000) had a second supply. Overall, although no rural household had more than two drinking water supplies, 0.6 percent of all rural households had three or more supplies for domestic purposes, including drinking. Thus, approximately 1.1 million rural households—5.0 percent—had multiple water supplies (for all domestic purposes), and the remaining 95.0 percent had only one supply for all domestic purposes. In addition, as already explained, of the 5.0 percent of households which had multiple supplies, only about 3 percent (676,000) households took drinking water from a supply which was not the major supply source. Thus, as already explained, at 97 percent of all rural households, the major household supply was the same as the drinking water supply, and the information in subsequent chapters of this report which refers to major household supplies therefore generally—but not always—includes data relevant to drinking water as well as to water used for other domestic purposes.

To shift back to the NSA findings regarding the 2.2 percent of rural households which had a second drinking water supply, it was most likely that one of the supplies was a community supply, but that the second supply was preferred for drinking. Furthermore, even though one of the two drinking water supplies was less likely to be a well than a community system, those two-system households with wells were even more likely to satisfy most drinking water needs from the second supply. In either situation, either purchased bottled water or hauled water were most likely to be the second supply—the one used most often for drinking.

SOURCES OF MAJOR WATER SUPPLIES

As was true for most of the data gathered in the NSA, data on water sources referred to sources of the major household supplies. Since there was only one major supply at each household, there was a direct correspondence between the number of major supplies—21,974,000—and the number of rural households.

As to the NSA findings, the water in 72.3 percent of all major household supplies (15.9 million) was extracted from a groundwater source, while only 11.4

percent of supplies (2.5 million) came from surface water sources. About 8 percent of all major supplies (1.8 million) came from mixed sources (a combination of sources), and about 6 percent (1.3 million) came from purchased water (water which a multiple-connection system obtained from another supplier). Relatively few cisterns were used by rural households, and as a result precipitation was the source for only 0.6 percent of all major supplies. The residual category accounted for 1.4 percent of supply sources.

As to subnational classification findings concerning major supply sources, groundwater use still predominated, but there was considerable variation among the various classifications. For example, groundwater was the source for the major supply in 87.5 percent of North Central households, but in only 56.7 percent of Western households. In contrast, surface water was the source for the major supply in 17.2 percent of Southern households, 11.0 percent of Western households, 10.4 percent of Northeast households, but only 3.5 percent of North Central households. Purchased water was the source at 14.4 percent of Western households, but at less than 6 percent of households in each of the other regions. Similarly, mixed sources provided the major supplies at 17.0 percent of Western households, and around 13 percent of Northeast households, but only at less than 8 percent of households in the other two regions.

About 60 percent of SMSA major household supplies were dependent on groundwater, compared to about 78 percent of nonSMSA major household supplies. Pronounced differences also occurred among the size-of-place findings. For example, although groundwater was still the most prevalent source for major supplies in large rural communities (in 58.9 percent), surface water was the source for 21.4 percent and mixed for 10.2 percent of the major supplies in those communities. In contrast, groundwater was the source for 81.4 percent of major supplies in small rural communities, whereas surface water was the source at only 11.0 percent of major supplies in those communities. Groundwater was the source for 73.3 percent of major supplies in other rural areas, and surface water was the source for only 10.1 percent of supplies in those communities.

SUMMARY OF CHAPTER V

The status of rural water supplies was described in the NSA in terms of five primary factors: quality, quantity, availability, cost, and affordability. In addition, the survey questioned rural water users about the effects of water quality, quantity, and availability on their households. Each of these broad subjects is explored in detail in Chapter V.

The status of rural water supplies was determined in the rural household. This emphasis was in keeping with the Congressional directive to obtain information on the number of rural residents who had inadequate service, limited access to supply, or exposure to waterborne health risks. New federal drinking water regulations reiterated this concern by requiring that most quality standards be met in the consumer's household, at his tap, rather than just at the supply facility or at the source. In the NSA, variables describing status included both laboratory-measured values (for water quality, for example) and perceived values (such as the user's evaluation of the water's taste and appearance).

QUALITY

In terms of laboratory measurement of water quality, major emphasis in the NSA was given to bacteriological, physical, and chemical water constituents which traditionally have characterized water quality. A total of 43 constituents were studied in the NSA (see Table I-1). The major focus was on measurements of health-related constituents of water, particularly in the subsample of 10 percent of the NSA water specimens, but some determinations were related more to aesthetic and economic considerations.

NSA PROCEDURE

The NSA results for laboratory—determined water quality were grouped in four broad categories—(1) bacterial content, (2) physical or chemical properties (turbidity, color, temperature, specific conductance, or hardness), (3) inorganic and organic constituents, and (4) radioactivity. Summaries of the findings in each of these categories are given below. Then a separate section is presented which summarizes the percentages of rural households which exceeded the NSA reference values established for 28 of the 43 constituents. As to the reference values themselves (listed in Table I-1), it was desirable to develop them in order to quantify households water quality. The federal primary and secondary drinking water regulations composed one set of standards which provided appropriate bases for the reference values, but other standards and criteria also were consulted in developing the values. The overall considerations behind selection of the values are too complex to summarize: the reader will find full details in Chapter V.

Bacteriological findings

Among bacteriological tests performed in the NSA, the total coliform count is regarded by many professionals as the best available general indicator of bacteriological water quality—despite technical shortcomings discussed in Chapter V. Accordingly, 28.9 percent of all rural households at the time of the NSA survey had supplies with total coliform levels which exceeded the NSA reference value (one bacterium per 100 milliliters of water) and which therefore probably required further assessment and possible remedial action. Rural supplies were above the reference value more often in the South and West than in other regions, more often outside of SMSAs than inside SMSAs, and more often in other rural areas than in large or small rural communities. High values also were much more common among supplies served by individual or intermediate systems than among supplies provided by community systems.

Table I-1
Constituents Measured in NSA Survey

Category	Constituent	NSA Reference Value (milligrams per liter of water, unless otherwise noted)	Measured in All NSA Household Samples or only in Group II Subsample
Microbial	Total coliform	Not more than one bacterium per 100 milliliters of water	All
	Fecal coliform	Complete absence of bacteria in a 100-milliliter sample	All
	Fecal streptococcus	None	All
	Standard plate count	500 colony-forming units per one milliliter of water	All
	Fecal coliform/fecal streptococcus ratio	None	All
Physical and Chemical	Turbidity	None	All
	Color	15 color units	All
	Temperature	None	All
	Specific conductance	None	All
	Total dissolved solids (as determined from conductance)	500	All
	Hardness (as determined from calcium and magnesium)	None	All
Inorganic	Calcium	None	All
	Magnesium	125	All
	Nitrate-N	10	All
	Sulfates	250	All
	Iron	0.3	All
	Manganese	0.05	All
	Sodium	More stringent: 20 Less stringent: 100	All
	Lead	0.05	All
	Arsenic	0.05	Subsample
	Selenium	0.01	Subsample
	Fluoride	1.4	Subsample
	Cadmium	0.01	Subsample

Table I-1 continued

Category	Constituent	NSA Reference Value (milligrams per liter of water, unless otherwise noted)	Measured in All NSA Household Samples or only in Group II Subsample
Inorganic (continued)			
	Mercury	0.002	Subsample
	Chromium	0.05	Subsample
	Barium	1	Subsample
	Silver	0.05	Subsample
Organic	Endrin	0.0002	Subsample
	Lindane	0.004	Subsample
	Methoxychlor	0.1	Subsample
	Toxaphene	0.005	Subsample
	2,4-D	0.1	Subsample
	2,4,5-TP	0.01	Subsample
Radioactive			
	Gross alpha	See Figure V-28	Subsample
	Gross beta	50 pCi	Subsample
	*Radium 226 *Radium 228 *Uranium *Stontium-89 *Strontium-90 *Cesium-134 *Tritium *Iodine-131	These constituents were not measured frequently enough to provide independent national estimates. (See text for details about NSA reference values.)	

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*Measured only if the laboratory analyst considered gross alpha or gross beta readings sufficient to warrant further investigation.

Furthermore, on the basis of NSA findings, 12.2 percent of all rural households had supplies which may have required attention because of the presence of at least one fecal coliform bacterium. In 1.6 percent of rural households (350,000), the fecal coliform count was higher than 200 colonies per 100 milliliters of water, a level which has been associated with increased occurrence of at least one organism with disease potential, indicating the possibility of heightened threat of disease. High values were proportionately most common outside of SMSAs, in other rural areas, and among households served by individual or intermediate systems.

Fecal streptococci were found in 1.8 million rural water supplies which also had fecal coliform bacteria. The ratio of these two organisms in the supplies suggested that contamination from animal wastes alone (a potential in 4.9 percent of all rural households) outweighed contamination from human wastes alone (a potential in 1.5 percent of all rural supplies). This trend was apparent in all regions of the US and also in households grouped by size of place and size of system.

In regard to general levels of bacteria as determined by the Standard Plate Count, values exceeding 500 per milliliter of water were found most often in the West and South. The high values were more frequent among nonSMSA households, among households located in other rural areas, and among households served by individual systems.

Physical and chemical characteristics

Of the physical and chemical characteristics studied in the NSA, turbidity probably was the most comprehensive, but least specific, indicator of water quality. Generally, domestic water with low turbidity is easier to disinfect, offers less opportunity for proliferation of bacteria, and may be less susceptible to taste and odor problems. Nearly 84 percent of rural household supplies had readings which were quite low (less than one nephelometric turbidity unit). Higher values were particularly prominent in the North Central and South, and in households served by individual or intermediate systems as opposed to community systems.

Households which had more than 500 milligrams per liter of total dissolved solids (as derived from specific conductance) also were most prominent in the North Central, where about one of every four households had concentrations of this magnitude. The proportion above this reference value was nearly as large in the West, but much smaller in the South and Northeast.

As to water hardness, the North Central once again had more than its share of supplies with very hard water. The median in the North Central (255.6 calcium carbonate equivalent units) was more than twice the median value for the nation, and considerably larger than the median for any other region.

Color was not a problem in rural supplies. Water temperature, on the other hand, was a potential aesthetic problem. Measured temperature was above 20° C at 43.8 percent of all rural households. The proportion of households with warm water was most prominent in the South, where about seven of every ten households had water temperatures over 20° C. The proportion over 20° C in the West was less than that in the South, but large in comparison to the Northeast and North Central. An important consideration, however, is that the 20° C mark refers to conventional abstract measures of desirable water temperature. Two additional considerations should be kept in mind. First, the temperature readings reflect not a yearly average but more likely the season in which they were taken—late summer and early fall. Second, household residents may consider water that is warmer than 20° C acceptable.

Inorganic constituent findings

Inorganic substances studied in NSA specimens ranged from those largely with aesthetic effects, such as manganese, to those predominately with health effects, such as lead. Certain of the constituents have received particular attention from investigators in the past, and it was anticipated that they might be associated with significant findings in the NSA. Among those constituents were calcium and magnesium, key elements in water hardness; nitrates, substances which pose a special health risk for infants; sulfates, substances which may make water distasteful and even cause diarrhea; and iron and manganese, elements which cause aesthetic and economic problems.

Calcium and magnesium were present in sufficient amounts to produce moderately hard water in rural US supplies, but the substances themselves were not implicated in any direct health effects by the NSA findings. Nitrates were not discovered in large concentrations in rural supplies—fully 97.3 percent of rural households were below the NSA reference value. Sulfates were potential problems in 4.0 percent of rural households, but more often for aesthetic rather than for serious health reasons. Iron and manganese concentrations posed aesthetic problems in a number of rural households, but about eight out of ten rural households met the NSA reference value for each metal.

Although households which exceeded the NSA reference value for any of these common constituents faced potential problems which required assessment and attention, the difficulties were not beyond the scope anticipated.

There were potentially important problems posed by several other inorganic substances, however. Those substances, all heavy metals, were lead, cadmium, and mercury. Lead was studied in all NSA sample households, and on the basis of the results, 16.6 percent of all rural American households (numbering 3.6 million) were above the NSA reference value for lead. Cadmium and mercury were studied in NSA subsample households, and on the basis of the results, 16.8 percent and 24.1 percent of US rural households, respectively, exceeded the NSA reference value.

The possible health implications of these findings are important. The three metals have different physiological effects, but the effects are known to be potentially serious, as is detailed in the separate reports on each of the heavy metals in Chapter V.

Study of a number of other inorganic substances in NSA subsample households showed other persistent, but less consequential, problems. Supplies at 13.7 percent of rural households surpassed the NSA reference value for selenium, although the concentrations were not large enough to pose health threats. About 4 percent of rural households had values beyond the reference value for silver, a situation which posed no immediate health threat but which involved a substantial number of rural households.

As to some of the other NSA constituents, amounts of arsenic, chromium, and barium in rural households generally were very small and posed few health concerns. Levels of fluoride also generally were well within the NSA reference value.

Organic constituent findings

Organic constituents studied in the NSA were limited to four chlorinated hydrocarbon insecticides and two chlorophenoxy herbicides. Of these six substances, only two were detected at all in NSA households. Those two substances were lindane—found only in small proportions of households in the West and South—and methoxychlor—found only in a small proportion of households in the West. None of the values for the substances exceeded or even closely approached the respective NSA reference values.

Radioactivity findings

Rural household supplies showed low levels of both gross alpha and gross beta radiation. The presence of background gross alpha radiation, in particular, was not surprising, since it is produced by natural sources commonly found in groundwater. Despite the prevalence of the radiation, levels of radioactivity were so low in the NSA that radiation in drinking water was not shown to be a national problem.

PROPORTIONS OF HOUSEHOLDS EXCEEDING NSA REFERENCE VALUES

Although 43 constituents were studied in the NSA, only 28 were assigned NSA reference values (see Table I-1). (The complex reasons for not assigning reference values for certain constituents are given in Chapter V.) The focus here is exclusively on the proportions of households exceeding the NSA reference values (Table I-2). As detailed in Chapter V, the reference values provide important benchmarks regarding health, aesthetic, and economic implications associated with the relevant concentrations of the constituents.

In examining Table I-2, it should be noted that for many of the 28 constituents, results were available for only a 10 percent subsample of the NSA sample. Specifically, the following constituents were analyzed for the subsample only: arsenic, selenium, fluoride, cadmium, mercury, chromium, barium, silver, endrin, lindane, methoxychlor, toxaphene, 2,4-D, 2,4,5-TP, gross alpha radiation, and gross beta radiation. All other constituent results in Table I-2 are based on the full NSA sample.

For the nation as a whole, concentrations sometimes exceeded the reference values for twenty out of 28 constituents. The constituents which were never found to exceed the respective reference values at any household were chromium, all six organic pesticides and gross beta radioactivity. Table I-2 indicates that the most frequent problems were caused by bacterial contamination, iron, lead, cadmium, and mercury. The NSA reference values were exceeded for each of these constituents in 15.0 percent or more of all rural households.

It is apparent from Table I-2 that there were distinct regional differences in the results. For example, households in the Northeast exceeded reference values for the smallest number of substances—fourteen. In contrast, households in each

Table I-2

Percentage of Rural US Households Exceeding NSA Reference Values Established for 28 of 43 Constituents Studied in the NSA (Reference Values in Parentheses)

	Total Coliform (1/100 ml)	Fecal Coliform (0/100 ml)	Standard Plate Count (500/ml)	Color (15 standard color units)
NATION	28.9	12.2	19.3	2.3
REGION				
Northeast	28.3	14.0	10.2	0.5
North Central	24.4	8.0	17.1	3.4
South	31.7	13.9	22.8	2.6
West	30.6	13.6	24.8	1.6
SMSA/NonSMSA				
SMSA	18.3	6.8	13.8	1.4
NonSMSA	33.9	14.7	22.0	2.8
SIZE OF PLACE				
Large rural communities	17.7	4.9	15.0	1.5
Small rural communities	19.6	4.0	11.7	5.4
Other rural areas	31.2	13.8	20.5	2.2
SIZE OF SYSTEM				
Community	15.5	4.5	13.9	1.9
Intermediate	43.3	20.2	17.8	1.9
Individual	42.1	19.8	26.6	3.0

Table I-2 continued

	Estimated Total Dissolved Solids (500 mg/l)	Magnesium (125 mg/l)	Nitrate-N (10 mg/l)	Sulfates (250 mg/l)
NATION	14.7	0.1	2.7	4.0
REGION				
Northeast	5.0	0.0	0.3	0.5
North Central	23.9	0.1	5.8	7.4
South	10.2	0.0	1.3	0.7
West	22.2	0.5	4.0	11.7
SMSA/NonSMSA				
SMSA	15.1	0.1	1.7	2.2
NonSMSA	14.5	0.1	3.2	4.8
SIZE OF PLACE				
Large rural communities	15.8	0.0	4.2	2.6
Small rural communities	17.7	0.0	4.7	7.5
Other rural areas	14.3	0.1	2.4	3.8
SIZE OF SYSTEM				
Community	15.0	0.0	1.6	4.2
Intermediate	13.4	0.4	3.0	1.7
Individual	14.7	0.1	4.1	4.2

Table I-2 continued

	Iron (0.3 mg/l)	Manganese (0.05 mg/l)	Sodium (100 mg/l)	Lead (0.05 mg/l)	Arsenic* (0.05 mg/l)
NATION	18.7	14.2	14.3	16.6	0.8
REGION					
Northeast	16.0	16.9	6.0	9.6	0.0
North Central	28.2	19.9	19.2	10.8	1.8
South	17.0	12.3	14.1	23.1	0.0
West	7.0	4.7	15.0	16.9	2.1
SMSA/NonSMSA					
SMSA	13.8	9.9	14.9	12.9	0.0
NonSMSA	21.0	16.3	13.9	18.3	1.2
SIZE OF PLACE					
Large rural communities	9.4	11.4	15.7	15.1	0.0
Small rural communities	23.3	21.7	17.0	18.1	6.6
Other rural areas	19.5	14.0	13.8	16.6	0.4
SIZE OF SYSTEM					
Community	7.7	7.2	15.8	17.7	0.9
Intermediate	28.7	23.3	10.3	20.5	0.0
Individual	29.9	20.7	13.3	14.1	0.8

Table I-2 continued

	Selenium* (0.01 mg/l)	Fluoride* (1.4 mg/l)	Cadmium* (0.01 mg/l)	Mercury* (0.002 mg/l)	Chromium* (0.05 mg/l)
NATION	13.7	2.5	16.8	24.1	0.0
REGION					
Northeast	0.0	0.0	1.6	22.0	0.0
North Central	25.7	1.8	20.7	31.8	0.0
South	2.1	2.7	17.3	25.0	0.0
West	41.3	6.2	27.1	10.4	0.0
SMSA/NonSMSA					
SMSA	14.4	1.6	21.4	21.5	0.0
NonSMSA	13.3	2.9	14.3	25.5	0.0
SIZE OF PLACE					
Large rural communities	16.5	2.9	19.8	16.2	0.0
Small rural communities	6.6	6.6	7.3	27.6	0.0
Other rural areas	14.0	2.1	17.3	24.6	0.0
SIZE OF SYSTEM					
Community	12.5	2.9	21.2	23.3	0.0
Intermediate	21.7	6.7	26.9	36.0	0.0
Individual	13.6	0.8	7.9	22.3	0.0

Table I-2 continued

	Barium* (1.0 mg/l)	Silver* (0.05 mg/l)	Endrin* (0.0002 mg/l)	Lindane* (0.004 mg/l)	Methoxychlor* (0.1 mg/l)
NATION	0.3	4.1	0.0	0.0	0.0
REGION					
Northeast	0.0	4.8	0.0	0.0	0.0
North Central	0.0	3.7	0.0	0.0	0.0
South	0.7	4.8	0.0	0.0	0.0
West	0.0	2.1	0.0	0.0	0.0
SMSA/NonSMSA					
SMSA	0.0	5.1	0.0	0.0	0.0
NonSMSA	0.4	3.6	0.0	0.0	0.0
SIZE OF PLACE					
Large rural communities	0.0	3.3	0.0	0.0	0.0
Small rural communities	0.0	3.6	0.0	0.0	0.0
Other rural areas	0.3	4.2	0.0	0.0	0.0
SIZE OF SYSTEM					
Community	0.0	2.1	0.0	0.0	0.0
Intermediate	0.0	3.4	0.0	0.0	0.0
Individual	0.8	7.1	0.0	0.0	0.0

Table I-2 continued

	Toxaphene* (0.005 mg/l)	2,4-D* (0.1 mg/l)	2,4,5-TP* (0.01 mg/l)	Gross Alpha* (see Fig.V-28)	Gross Beta* (50 pCi/l)
NATION	0.0	0.0	0.0	0.5	0.0
REGION					
Northeast	0.0	0.0	0.0	0.0	0.0
North Central	0.0	0.0	0.0	0.0	0.0
South	0.0	0.0	0.0	1.3	0.0
West	0.0	0.0	0.0	0.0	0.0
SMSA/NonSMSA					
SMSA	0.0	0.0	0.0	0.0	0.0
NonSMSA	0.0	0.0	0.0	0.8	0.0
SIZE OF PLACE					
Large rural communities	0.0	0.0	0.0	0.0	0.0
Small rural communities	0.0	0.0	0.0	0.0	0.0
Other rural areas	0.0	0.0	0.0	0.6	0.0
SIZE OF SYSTEM					
Community	0.0	0.0	0.0	1.0	0.0
Intermediate	0.0	0.0	0.0	0.0	0.0
Individual	0.0	0.0	0.0	0.0	0.0

*Constituent analyzed for only the 10 percent NSA subsample.

of the other three regions surpassed the reference values for eighteen of the twenty constituents.

In terms of general regional water quality implications, households in the Northeast clearly were least likely to have problems. Households in the North Central generally were most likely to have potential water quality problems—whether the problems were related to health, aesthetic, or economic effects. However, potential bacteriological problems, as indicated by the findings for total coliform and fecal coliform, were most likely to occur in the South and the West. Households in the South were most likely to exceed the reference value for lead; households in the North Central were most likely to be above the reference value for mercury; households in the West were most likely to surpass the reference value for cadmium and selenium.

NonSMSA households had a higher potential for water quality problems than did SMSA households. In all, nonSMSA households had higher percentages above the reference values for fourteen of the twenty constituents. In contrast, SMSA households had higher percentages above the reference values for only four of the twenty constituents. The situation among nonSMSA households was particularly serious because of the numbers of households involved: about two-thirds of the total US rural population lived in nonSMSA areas.

Values for total coliform bacteria, lead, and mercury exceeded the respective reference values in over 15.0 percent of the households in every size-of-place category. Iron problems tended to be more prominent in small communities and in other rural areas. Total dissolved solids and sodium problems were slightly higher in large and small rural communities than in other rural areas. Manganese problems seemed to be concentrated in small rural communities, while selenium and cadmium problems occurred most frequently in other rural areas and large rural communities.

Among all categories of system size, values for mercury and total coliform bacteria exceeded the reference values in over 15.0 percent of the households. Sodium appeared over the reference value most often among households served by community systems. Selenium was prominent among households served by intermediate systems. Five constituents were found in concentrations exceeding the reference values in more than 15.0 percent of rural households served by community water systems or by individual systems. This situation was the same for seven constituents among households served by intermediate systems. More than 15.0 percent of rural households exceeded the reference value for total coliform, regardless of the size of supply system serving the household.

Following the completion of the water collection and laboratory assessment, it was discovered that the ampules containing the acid preservatives could induce an artificial lead and cadmium background in the water specimens by an average of 36 parts per billion lead and 0.92 parts per billion cadmium. If the NSA specimens were thus contaminated, and it is likely they were, the estimate of households above the lead reference value would be reduced from 16.6 percent to 9.2 percent. The reduction in the estimated proportion of households above the cadmium reference value would be reduced from 16.8 percent to 15.9 percent.

PERCEIVED WATER QUALITY

In addition to laboratory analysis, people's perceptions provided supplementary information concerning the quality of water supplies in rural America. Subjective judgments revealed the prevailing conditions of the household water supply. Specifically, NSA respondents were asked about the odor, taste, clarity, color, sediment content, and temperature of the major household water supply. In those instances where problems were identified, further questioning revealed the severity, frequency, and possible reasons for the problem. The summary which follows focuses on selected highlights of the NSA findings, since, as was true for the laboratory findings, many of the details were too complex to be summarized briefly.

Odor

About one-quarter of all rural households (approximately 5.6 million) reported odor in the major household water supplies. Although strong odors usually were only detected occasionally in these households, slight odors were present most or all of the time. The reported odors were most often associated with deliberate or planned activities and they most often were described as smelling like chlorine.

Little variation was detected among households in the four regions of the United States, or between SMSA and nonSMSA households, in either the intensity or the duration of water supply odors. However, in terms of the size-of-place and size-of-system comparisons, odor conditions were somewhat different. Specifically, more households in large rural communities reported odors in their water supplies (35.6 percent, compared to 33.2 percent for small rural communities and 23.5 percent for other rural areas). Not only were water supply odors more prominent in large rural communities, but odors were also more intense and of longer duration. Similarly, odors were more prominent in household water supplies served by community systems (32.3 percent, compared to 19.8 percent for intermediate systems and 18.3 percent for individual systems).

Taste

Although odor and taste generally would be expected to occur together, water supply tastes were reported more often than were odors. In all, 5.6 million households reported water supply odors; 7.8 million households reported tastes. These tastes were most often described as slight, but persistent throughout the year, or occasionally strong. As with odors, water supply tastes were most often attributed to planned activities. While water supplies sometimes tasted like chlorine, they most often tasted like mineral water.

The subnational variations in water supply tastes as described by rural residents followed somewhat the same pattern as seen for water supply odors. While little variation was detected among households in the four US regions and between SMSA and nonSMSA households, taste conditions varied for the size-of-place and size-of-system comparisons. In particular, more households in large rural communities reported tastes in their water supplies (45.4 percent, compared to 38.8 percent for small rural communities and 33.9 percent for other rural areas). Although water supply tastes occurred more frequently among households located in large rural communities, intense tastes of longer duration were no more prominent here than in small communities or other rural areas. Among households served by supply systems of different sizes, 42.4 percent of those served by community systems reported water supply tastes, compared to 32.1 percent of households served by intermediate systems and 27.8 percent of households served by individual systems.

Cloudiness

Components of water as perceived by sight—cloudiness, color, and sediment content—have potential implications for water quality. Furthermore, these characteristics may affect people's attitudes towards their water supplies.

Across the nation, 5.9 million households noticed a cloudy condition in their water supplies. The cloudiness was most often characterized as slight and only occasionally present. Water supply cloudiness was most often attributed to breakdowns in supply technology or to planned activities.

Differences in cloudy conditions were observed for all of the subnational groupings. Comparing across regions, problems with cloudiness in the water supply were most often reported among households in the South and West (29.9 percent and 27.4 percent, respectively); cloudy conditions were reported least often among households in the North Central and Northeast (24.7 percent and 22.6 percent, respectively). These conditions were slightly more intense and of longer duration in the North Central and West.

The SMSA/nonSMSA comparison showed that proportionately more nonSMSA households noticed cloudiness in their water supplies (28.9 percent) as compared to SMSA households (22.7 percent). These differences reflected the higher proportion of nonSMSA households which reported infrequent slight cloudiness, as opposed to more persistent or intense cloudy conditions.

Households situated in large rural communities reported cloudy conditions more often than those in small rural communities or other rural areas. Also, cloudy conditions were slightly more persistent and intense in large rural communities. Consistent with the variations in the size-of-place comparison, community systems were least often free of any cloudiness.

Color

Color in rural water supplies was noticed less often than cloudiness. In total, 4.5 million households across the nation reported that the water supply had color. While the colored condition was most often characterized as slight and only occasionally noticeable, 1.4 million households reported a prevalent color in the water supply. The presence of color was most often attributed to breakdowns in supply technology although mineral content of the water and planned activities were frequently cited.

Water supply color varied somewhat according to region, size of place, and size of system. While equal proportions of households in each of the four regions reported that color was present in the water supply, proportionately more households in the West characterized the colored condition as severe. Compared to households in small rural communities and other rural areas, a larger proportion of households in large rural communities reported color in the household water supply.

Sediment

Approximately one-third of all rural households (7.3 million) experienced some degree of sedimentation. For most households reporting sediment, the condition was an occasional problem, and did not involve heavy sediment. Rural residents often thought that the sedimentation resulted from either a breakdown in the physical facilities of the water system or the inadequacy of the physical components of the system.

Except for regional differences, subnational comparisons showed no appreciable variation in the frequency and intensity of sediment conditions. The chief regional difference was the much higher proportion of households in the West that reported sediment in the water supply. In the West, 43.5 percent of households reported sediment in the water, compared to 34.2 percent in the North Central, 33.1 percent in the Northeast, and 29.5 percent in the South.

Temperature

As expected, substantial regional differences were observed in the perceived temperature of rural water supplies. Water supplies in the Northeast and North Central were thought to be predominately cold (63.3 percent and 53.8 percent, respectively) while supplies in the South and West were most often characterized as cool (74.1 percent and 54.8 percent, respectively). Overall, warm water supplies were infrequent, reported by less than 10 percent of the households in each of the regions.

A comparison of SMSA and nonSMSA households showed little variation from national estimates. With respect to the size-of-place comparison, however, slight differences were observed in water supply temperatures. Generally, with decreasing place size, the proportion of cold supplies increased and the proportion of warm supplies decreased. More specifically, cold supplies ranged from 30.5 percent in large communities through 39.2 percent in other rural areas; warm supplies ranged from 11.4 percent through 5.2 percent.

Consistent with the pattern seen in the size-of-place comparison, cold water temperatures were reported by 53.8 percent of households served by individual systems, 44.2 percent served by intermediate systems, and 24.1 percent served by community systems. About 2.1 percent of households served by individual systems reported warm water temperatures, as did 4.9 percent of those served by intermediate systems, and 9.2 percent served by community systems.

WATER QUANTITY

Although water quality is a paramount concern, water quantity also is an urgent consideration. However, water consumption is difficult to measure unless the household supply is metered. In the NSA, meter reading was done primarily at households served by community systems (those with fifteen or more connections). Water usage at households served by individual systems was more difficult to ascertain since devices for metering were not employed—although persons who used hauled or purchased bottled water could usually provide fairly accurate information. NSA investigators thus assessed potential water use from individual supplies by measuring pump capacity, the effective volume of pressure tanks associated with the pump, or the capacity of storage tanks. In addition to the above assessments, a sense of water usage was obtained by asking about the respondent's perception of the amount of water available to the household.

The major findings about recorded and perceived water use were:

- For the 4.5 million rural households which could provide bills with sufficient information, the median daily household consumption was 664 liters (175 gallons). Median daily per capita consumption was 227 liters (60 gallons).

- There were roughly 9.8 million rural households which had on-premise pumps. The median pump capacity was 22 liters (6 gallons) per minute. Most of these households (9.5 million) also had at least one pressure tank with a median capacity of 114 liters (30 gallons).

- Among the approximately nine million rural households where the effective volume of the pressure tank was measured, the median effective volume was 13 liters (3 gallons). About 4 percent of these tanks, however, were completely waterlogged (the cushion of compressed air in the tank was entirely dissipated).

- Auxiliary storage tanks were relatively rare: they were reported at only about 945,000 households (or 4.3 percent of all rural households). Although rare, these tanks usually were large; the median size was about 760 liters (200 gallons).

- While few households relied upon hauled water (269,000) and purchased bottled water (102,000) as the major supply, those which did used smaller quantities of water than households served by community systems. The median quantity hauled each month was 609 liters (161 gallons); the median quantity purchased each month was 5,900 liters (1,557 gallons).

- The perception of most rural households was that water supplies were ample: fully 17.7 million households reported that the major household supply completely satisfied water requirements, and another 3.6 million households reported that it usually or almost always provided sufficient water. Only about 700,000 households reported that the supply usually or always provided an unacceptable quantity of water; insufficient quantity was most often attributed to an inadequacy of the physical facilities of the supply.

- As to regional variations among households metered and billed for water, the West and South had the highest median per capita daily consumption (234 liters, or 62 gallons, each) while the North Central had the lowest (188 liters, or 50 gallons).

- Consistent with the pattern seen in the regional comparison of metered quantity, the potential for greater per capita consumption was evident in the West based on pump capacity, effective volume, and tank size. The median pump capacity in the West was at least twice the capacity of pumps in other regions (48 liters, or 13 gallons per minute); pressure tanks had nearly double the effective volume (23 liters, or 6 gallons); and storage tanks were at least seven times as large, with a median size of 3,777 liters (997 gallons). The only exception was in the South, where median storage tank size approximated that in the West.

- As to regional differences in household perception of water quantity, Western households reported more frequent problems with quantity than households in the other three regions. For example, 7.2 percent of households in the West reported either that the water supply usually did not provide enough water or that it never did, compared to 2.4 percent in the Northeast, 1.9 percent in the North Central, and 2.8 percent in the South.

WATER AVAILABILITY

In the NSA, availability was defined in terms of the supply's reliability, or its uninterrupted service, and the supply's accessibility, or the difficulty of obtaining water from the supply.

RELIABILITY

On the whole, supplies which served rural households were fairly reliable. Of the estimated 22 million rural households across the nation, only 5.6 million reported water supply breakdowns. Among the households reporting breakdowns, the majority had only one or two during the year preceding the NSA, and only a small proportion (less than 2 percent) reported as many as six or more.

Slightly more than 3.2 million rural households (about 15 percent of all rural households) reported breakdowns which lasted six or more hours (considered severe by NSA standards). Regardless of the severity of the breakdowns, the vast majority of the 5.6 million households that reported breakdowns (4.6 million) attributed them to problems outside of the household. When a breakdown occurred, most households (4.5 million) waited until the supply was repaired or borrowed water from relative, friends, or neighbors.

In terms of regional differences, household supplies in the South seemed to be somewhat less reliable than supplies in the other regions (29.2 percent reported breakdowns, compared to 25.3 percent in the North Central, 21.8 percent in the Northeast, and 20.5 percent in the West). Similarly, severe water supply breakdowns tended to be more prevalent in the South, where they were reported by 17.1 percent of the households. While the majority of households in each region indicated that supply breakdowns originated outside of the structure, a much larger proportion of households in the West (about 98 percent) attributed breakdowns to that source.

Although the reliability of SMSA and nonSMSA supplies was similar, there were differences according to the size-of-place classification. Generally, households in small rural communities reported supply breakdowns more often than did households in large rural communities or other rural areas (29.7 percent, compared to 22.2 percent in large rural communities and 26.0 percent in other rural areas). Similarly, water supply breakdowns which were considered severe by NSA standards occurred more often among households situated in small rural communities (reported at 16.6 percent).

Compared with households using individual or community systems, a larger proportion of households served by intermediate systems reported one or more supply breakdowns (33.1 percent, compared to 26.4 percent served by community systems and 22.8 percent served by individual systems). Also, a greater proportion of households served by intermediate systems reported breakdowns that were severe. In response to supply breakdowns, households served by community systems generally waited until service was restored, while those with intermediate systems borrowed water or waited, and those with individual systems borrowed water or took action to repair the supply.

ACCESSIBILITY

An accessible water supply was defined as one which provided water when needed and was not in an inconvenient location. Furthermore, the supply had to provide water at an appropriate pressure—as measured by a pressure gauge which the NSA interviewer applied to the tap.

The convenience of the supply's location was determined for nearly half of rural households (48.2 percent) by distance measurements between the household and the point of withdrawal from the source. These measurements were made at households served by wells, springs, surface water, or cisterns—but not at households served by hauled supplies, purchased bottled water, or community water systems (the last of which was assumed to provide maximum convenience). The NSA results indicated that supply sources generally were at a convenient distance from the 10.6 million households at which measurements were made. However, comparatively great distances were recorded at a certain proportion of households. This generally meant the need for more extensive piping or other transmission systems to transport water from the source to the households. Specifically, about 52 percent of the supplies for which a distance measurement was recorded withdrew water from a point that was within ten meters (33 feet) of the household. For another 31.9 percent, the point of withdrawal was eleven to 50 meters away (36 to 164 feet). In contrast, less than 1 percent of rural households reported distances which exceeded 1,000 meters (more than half a mile).

Water pressure at rural households also was generally sufficient. The median measurement was 39 pounds per square inch, although 1.4 million households had supplies with a pressure of 20 pounds per square inch or less. This corresponded closely to the number of rural households that perceived the usual water supply pressure to be too low (1.6 million households). Another 2.0 million rural households with pressurized supplies reported either that the pressure was too high or that it fluctuated. Pressure difficulties were most often attributed to some unspecified inadequacy of the water supply's physical facilities.

As to regional differences, there was a great deal of variation in the distance between the dwelling unit and the point where the water was withdrawn from the source. Distance measurements were greater in the South and West than in the Northeast or North Central.

Water supply pressure also varied from region to region. The lowest pressure readings (20 psi or less) were most common in the North Central, and the highest readings (61 through 100 psi) were most common in the West. In all regions, the great bulk of supplies were perceived to have satisfactory water pressure.

Supplies serving rural America tended to be less accessible for nonSMSA households than for SMSA households. Among nonSMSA households, 49.2 percent of supplies had the point of withdrawal within ten meters of the dwelling unit, compared to 58.4 percent of supplies among SMSA households. Distances which exceeded 100 meters were recorded for about 7 percent of nonSMSA supplies, compared to roughly 3 percent of SMSA supplies. Also, a similar pattern was seen in terms of the water pressure readings. That is, water pressure tended to be lower among nonSMSA households and therefore the supply was considered less accessible.

The size-of-place comparison showed a great deal of variation in each of the indicators of accessibility. NSA results showed that water supplies in other rural areas were least accessible in terms of distance to source, while those situated in small rural communities were most accessible. Roughly three-fourths of all supply sources in small rural communities were located within ten meters of the dwelling unit, compared to about half of the supplies in other rural areas. At the other extreme, the only water supplies that withdrew water from a source over 1,000 meters away from the household were located in other rural areas.

Higher pressure readings were more common in large rural communities than in small rural communities or other rural areas. In large communities, only 3.1 percent of supplies had pressure readings between one and twenty pounds per square inch, compared to 5.7 percent of supplies in small rural communities and 8.2 percent of supplies in other rural areas. Readings of from 61 through 100 pounds per square inch were found in 22.4 percent of supplies in large communities, compared to 14.9 percent of supplies in small rural communities and 12.0 percent of supplies in other rural areas.

Finally, water pressure as determined by household representatives was thought to be "about right" less often among households in large communities. Although the differences were only slight, 79.3 percent of households in large communities reported that the pressure was about right, compared to 82.7 percent in small communities and 83.8 percent in other rural areas.

Size-of-system differences were also observed when comparing distances to the source. (Since the information gathered did not apply to community systems, the comparison was restricted to individual and intermediate systems.) Supplies for households served by intermediate systems had greater distances between the point of withdrawal from the source and the dwelling unit. Among households served by individual systems, 57.8 percent of supplies had the point of withdrawal either on the premises or within ten meters of the structure, while this was true for only 27.0 percent of supplies at intermediate-system households. With respect to greater distances, 18.1 percent of households served by intermediate systems were situated 101 meters or more from the source, while only 3.0 percent of those served by individual systems were that distance.

Pressure readings also varied according to the size of the water system. Among households served by individual and intermediate systems, pressure was virtually never more than 60 pounds per square inch, and most often between 21 and 40 pounds per square inch. In contrast, almost one-quarter of community-system households had pressure readings between 61 and 100 psi, and close to 50 percent had readings between 41 and 60 psi. Nevertheless, more households served by community systems expressed dissatisfaction with the supply's water pressure, even though on the average their pressure readings were higher. To summarize, 80.8 percent of households served by community systems reported that the usual pressure was about right, compared to 85.2 percent of households served by individual systems and 87.9 percent served by intermediate systems.

EFFECTS OF QUALITY, QUANTITY, AND AVAILABILITY

In the NSA interviews, residents were questioned about problems or inconveniences which they associated with inadequacies of various conditions of their water supplies. Additionally, residents were specifically asked whether anyone living in the household or any visitors to the household had become ill from drinking the household water.

On the basis of inquiries at the household, illnesses among rural residents, visitors, or both, during the year prior to the NSA study were thought to be associated with the water supply in only 2.3 percent (or 505,000 households) of all rural households. Diarrhea was the most common illness although a variety of maladies were reported. As to problems not related to health, two million households reported inconveniences resulting from water supply conditions ranging from discolored laundry to deposits on household fixtures.

COST

The cost of water to households is determined by a number of factors. Though the NSA focused on the household, there was no reliable way to collect operating and maintenance cost data for individual supply systems. Also, although some households served by intermediate systems were billed on a regular basis, no cost information was available. Therefore the cost analysis was restricted to community-system households which could provide the relevant billing data. (The operating and maintenance cost of the community systems supplying the water was a separate consideration, as explained in Chapter VIII.) Although cost could be quantified only for community-system households, perceived cost was assessed for all rural households.

Another difficulty in assessing household water cost was that water bills sometimes were unavailable at households served by community systems. Therefore, it was possible to calculate costs for only 4.6 million households, essentially one-fifth of the nation's rural households. The NSA findings showed that the median household water cost for every thousand gallons consumed was $1.35 nationally, while the median monthly household cost was $7.00.

When NSA respondents were queried about water costs, the majority felt the cost was reasonable, or that the water was inexpensive (17.3 million, combined). On the other hand, the water was considered expensive or very expensive at about three million households. Although a significant number of households reported that costs had increased during the year prior to the survey (7.9 million), the majority (12.2 million) judged costs to have remained the same. In slightly less than one million rural households, it was reported that no cost was associated with the water.

As to costs in the different regions, median costs per thousand gallons ranged from $1.33 in the South to $2.00 in the West. In the Northeast and North Central, the medians were $1.34 and $1.50, respectively.

Although the cost of water was thought to be reasonable or inexpensive by residents at the great majority of rural households in all four regions, water was reportedly expensive or very expensive for a greater proportion of households in the South and West. In a related finding, the cost of water was reported to have increased in a large proportion of households in the West (42.6 percent, compared to about 35 percent in the other three regions). However, water costs appeared to have remained the same over the past year for the majority of households in each of the four regions.

In general, households within SMSAs had lower water costs per thousand gallons than did those outside SMSAs. Half of the households within SMSAs were charged $1.08 or less for every thousand gallons, whereas half of nonSMSA households were charged $1.62 or less. Despite these findings, residents living within SMSAs believed that their water costs were higher than residents living in the more rural areas. (However, it should be recalled that billing costs could be calculated for only 4.6 million households, whereas all households responded to perceived cost.) The most noticeable difference in the SMSA/nonSMSA comparison was that 19.1 percent of SMSA households reported that the water supply was expensive or very expensive, compared to 12.3 percent of nonSMSA households.

Median water costs varied only slightly according to the size of community in which the household was located. In large rural communities, the median cost per thousand gallons was $1.45; in small communities, it was $1.60; and in other rural areas, it was $1.33. Likewise, perceived costs tended to rise with population size. For example, about 14 percent of households in small rural communities and other rural areas reported that the water supply was expensive or very expensive, compared to 21.6 percent of households in large rural communities. In addition, proportionately more households in large rural communities reported cost increases during the preceding year (44.4 percent, compared to 38.7 percent in other rural areas and 31.8 percent in small rural communities).

The size-of-system comparison yielded differences which were not unexpected. For example, households served by community water systems predominately paid for their water by a regular billing (83.0 percent). The most common way of paying for water among individual- and intermediate-system households was by direct household operation and maintenance of the supply (about 95 percent and 65 percent, respectively).

Cost comparisons were restricted to perceived costs since only community water systems in the NSA billed for their services. Just as perceived costs were highest at households in large rural communities, they were also highest at households served by community water systems. It was possible, however, that rural residents were not aware of the costs involved in the operation and maintenance of individual supplies, whereas a regular billing was a reminder of the direct cost associated with water consumption.

AFFORDABILITY

In the NSA, affordability was measured in two ways. First, a ratio of billed cost to total household income was multiplied by 100 to calculate the percent of household income paid for water. Second, NSA respondents were questioned about whether—if offered a supply that was good to drink and provided as much water as needed—they would be willing to pay more, or the same amount they were currently paying for their existing supply. The assumption was that respondents who would be willing to pay either more or the same felt that their present water supply was affordable.

For the 4.6 million households which could provide billing information, the proportion of household income paid for water ranged from 0.04 percent through 15.60 percent. One-quarter of these households paid 0.30 percent or less of household income for water. Half paid 0.60 percent or less. Three-quarters paid 0.99 percent or less, and one-quarter paid 1 percent or more.

In terms of the second measure of affordability, a willingness to pay either the same or more for the ideal supply was reported in 95.8 percent of all rural households (21 million). A willingness to pay less was expressed at 3.6 percent of rural households (0.8 million). This response may have signalled a supply which was not affordable in light of other unidentified household expenditures.

With respect to regional differences, households in the Northeast paid a smaller proportion of income for water than those in the South, West, or North Central. Sepcifically, the median cost-to-income ratio in the Northeast was 0.38, compared to about 0.60 percent in the South and North Central, and 0.73 in the West. The SMSA/nonSMSA comparison showed a more striking difference in the cost of water in relation to household income, the ratio being much higher for households located outside SMSAs. In fact, the median ratio for nonSMSA households was twice as high as it was for households located within SMSAs (0.72 versus 0.36). Finally, the median cost-to-income ratio was much higher for large and small rural communities (0.82 and 0.76, respectively), than for other rural areas (0.52).

The regional comparison of perceived affordability showed that households in the Northeast more often indicated a willingness to pay more for an ideal water supply than households in the other three regions. Perhaps this was an indication that they could afford to pay for a supply which was superior to the one which they currently received. Likewise, a larger proportion of SMSA households were willing to pay more for water.

SUMMARY OF CHAPTER VI

Chapter VI considers selected aspects of the material presented in Chapter V and incorporates this information into a number of composites or summary measures. These composites or indices are designed to produce a set of values or scores that can be used to distinguish rural households with respect to (1) the quality of the water provided by their major supply and (2) the supply's availability. Indices for quantity and cost were not constructed because the data for these status factors were not extensive enough to summarize collectively. Besides disclosing patterns of variation among rural households, the indices developed in Chapter VI also function as analytical devices in Chapters IX and XI. In short, the indices discussed in Chapter VI were developed to reduce the information on quality and availability to a level that was manageable within the NSA's descriptive and analytical framework.

The formation of each composite involved combining variables according to a particular set of principles. These principles suggested how the variables were to be aggregated, given the substantive purpose of the index. The purpose of each index was determined by the information that was being summarized and the complexity of the factor being measured. Referents for water quality included concentrations of physical substances that were assayed by laboratories as well as selected perceptions of rural people. Availability, on the other hand, encompassed material about recorded water supply pressure, the distance between the household and the point at which water was withdrawn from the source, and supply breakdowns. To emphasize the distinctive aspects of these data, four indices were developed for water quality, two composites for availability.

Three of the four quality indices were based on NSA laboratory findings. The first of the three indices was keyed to the potential health significance of relevant findings. The second was geared to aesthetic and economic implications of the findings. The third was keyed to the general expression of water quality, whether related to health, aesthetic, or economic considerations. In contrast, the fourth water quality index was keyed to perceptual data obtained in the NSA. Except for the general index, which comprised the complete set of indicator constituents chosen for the indexing effort, the composites were independent or mutually exclusive. Therefore, each index was unique and satisfied a need that could not be fulfilled by the other three. Each index was further distinguished by the method used to combine the constituents and the interpretation of the index scores, although all four quality indices permitted the same relative comparisons.

In spite of their dissimilarities, the three water quality indices constructed from the laboratory data revealed generally similar trends within the subnational groupings (the findings for the nation were difficult to compare since the purpose of each index was different). Scores for all three indices tended to be higher for households in the North Central, lower for households in the Northeast. These results suggested that household water supplies in the North Central were more likely to have health risk, adverse aesthetic and economic effects, and lower general quality than household supplies in the South, West, or Northeast. Another implication of these findings was that households in the North Central and West tended to have water quality which was lower than the national average.

Two of the three composites also showed generally similar trends in the size-of-system grouping. Households using intermediate systems had higher values in the health risk and general water quality indices, while households using individual systems or community systems had lower scores. This indicated that households using intermediate systems received water of lower quality than households served by individual or community systems—although there were no appreciable differences on the aesthetic/economic index according to the size-of-system grouping. Despite these trends, scores for the three indices generally varied little in the SMSA/nonSMSA and size-of-place groupings. The one exception was that scores on the general water quality index indicated that households in small rural communities received lower quality water than did households in large rural communities or other rural areas.

The preceding patterns of variation were different from those associated with the perceived quality index. Regional distributions suggested that, on the average, households in the South tended to have somewhat lower scores than households in the Northeast and North Central, and that households in the West tended to have higher scores. This indicated that households in the South apparently perceived the quality of their water supplies to be slightly better than did households in other regions; households in the West perceived the quality of their water supplies to be lower than did households in other regions. Additionally, while the perceived quality composite revealed no appreciable differences among SMSA versus nonSMSA households, the composite indicated that households in other rural areas perceived the quality of their water supplies to be better than did households in small and large rural communities. Finally, the direction and magnitude of differences on the index showed a pronounced tendency for the quality of water supplies to be perceived as better in rural households with individual systems than in households using intermediate or community systems.

The two composites of availability were developed to measure the reliability and accessibility of rural water supplies. Consistent with the approach in Chapter V, the reliability index drew on information about minor and severe supply breakdowns, while the accessibility index used data on water pressure and the distance between the household and the point of withdrawal. Since each index measured a unique aspect of availability, they were independent.

According to the reliability index, rural water supplies tended to be very reliable when considered nationally. Since the scores on the accessibility index were generally low, rural water supplies were also accessible. Subnationally, however, the indices generally disclosed different patterns of variation. The supplies of households in the South were less reliable than the supplies of households in the other regions, but supplies in the North Central were most inaccessible relative to the supplies of households in the Northeast, South, and West. Similarly, the supplies of households in large rural communities were more accessible, while the supplies of households in small rural communities were somewhat less reliable than those in large rural communities or other rural areas. The only parallels between the two indices were in the size-of-system comparison, where the supplies of households on intermediate systems were least reliable and accessible, and for the SMSA/nonSMSA contrast, where only trivial differences were detected.

SUMMARY OF CHAPTER VII

In Chapter VII, the scope of the NSA report is expanded to include various physical and technical aspects of water supplies and their organizational features. This examination is done in the context of water systems, since the systems have a strong influence on the size and technical features of the supplies. Chapter VIII, dealing with the economics of water supply, complements this chapter and the two chapters represent the extent of the NSA investigation of supply systems.

The systems are typified according to three major system-size categories —individual, intermediate, and community systems. As noted in Chapter II, the individual systems served single households, the intermediate systems had two through fourteen connections, and the community systems had fifteen or more connections. As to numbers of the respective systems at the time of the NSA survey, there were 8,765,000 individual systems, 845,000 intermediate systems, and 34,000 community systems providing water to rural US. Although individual systems were by far the most numerous, intermediate and community systems served proportionately more rural households, since each of those systems had multiple connections, whereas each individual system had only one connection. Specifically, community systems served 10,981,000 households, compared to 8,765,000 households served by individual systems and 2,228,000 households served by intermediate systems.

INDIVIDUAL SYSTEMS

The profile of individual systems was developed so that certain overall features, such as source and ownership, were presented first. Then engineering features which generally were external to the household and which were related to selected aspects of water supply (principally to water quality) were described.

Next, the system was traced from the external engineering features to findings regarding water transmission to considerations within the household structure, such as types of water treatement devices, which seemed relevant to the status of rural water supplies. Finally, the household experience with laboratory assessment of water quality was investigated.

Major findings of these investigations are presented in this summary. The diverse nature of the material in Chapter VII requires considerable selectivity in the summary here. Thus, only the major findings are presented emphasizing the nation as a whole, although some references are made to regional, SMSA versus nonSMSA, and size-of-place findings. Furthermore, findings which require detailed qualification and explanation generally are omitted here to avoid the possibility of oversimplification—a problem which otherwise would be particularly acute in relation to the subnational findings. A further qualification is that, as was true in Chapters V and VI, the water supplies described in Chapter VII are the major household supplies.

As to the findings related to overall features of individual systems:

- Groundwater (from wells or springs) was the source for fully 93 percent of the 8.8 million individual systems in rural America. Groundwater use was particularly prevalent in the Northeast and North Central.
- Although groundwater usually was associated with wells, 275,000 individual systems had springs. Most (about 93 percent) of the springs were located either in the Northeast or the South, and all of the springs were in other rural areas.
- About 2 percent of all individual systems—those with cisterns—had precipitation as a source.
- Only about 1 percent of all individual systems had a surface water source.
- About 4 percent of individual systems used purchased bottled or hauled water for which the sources could not be determined.

- Nearly all individual systems—97 percent—were owned by individuals. A few systems—about 1 percent—were owned by private firms. For the remaining 2 percent of systems, there was a variety of arrangements, ranging from no ownership to ownership by a cooperative.

- The median number of years during which households were served by individual systems (for those systems for which information could be obtained) was 7.1 years. The majority of systems had served households for ten years or less.

As to specific external engineering features, those associated with wells were reported here first, those associated with springs next, those relevant to cisterns after that, and those relevant to surface water supplies last. Features of individual systems using purchased bottled or hauled water were not considered since the sources could not be determined. Major findings about features associated with wells were:

- About 90 percent of the 8.8 million individual systems in rural America relied on wells.

- Individual wellheads most often terminated above ground—frequently under protective covering. However, although above-ground-termination was used for about 60 percent of wells across the nation, this arrangement was found at only about 47 percent of wells in the Northeast and 51 percent of wells in the North Central. In the South, on the other hand, 77.0 percent of wells terminated above ground.

- Less than one-fifth of all wellheads were in well pits, an arrangement which was particularly rare in the South, where only 10.9 percent of wells had well pits.

- Less than one-fifth of wellheads in the nation were entirely buried, although the proportion of buried wells rose to 31.0 percent in the Northeast.

- Nearly six of every ten individual wells were drilled. However, the proportion of drilled wells was considerably smaller in large rural communities (about 38 percent of wells there) than in small communities or other rural areas (both of which had about the national average).

- Only 12.7 percent of wells were driven, and a similar proportion were dug. The proportion of driven wells, however, was much greater in large rural communities (about 42 percent of wells there) than in small communities or in other rural places (about 10 and 12 percent of wells in those places, respectively). As to dug wells, the proportion was larger for nonSMSA systems than for SMSA systems—14.3 percent versus 8 percent.

- About 6 percent of wells were either bored or jetted; the type of construction could not be determined for nearly 11 percent of individual wells.

- The median depth of individual wells for which information was available (about 88 percent of all wells) was 26.8 meters (87.9 feet) from ground level to bottom of shaft.

- About 39 percent of the 6.8 million drilled, driven, bored, or jetted wells in rural America were not grouted; about 35 percent were grouted; grouting status for the other 26 percent of wells could not be determined. (Grouting is a pollution countermeasure employing cement to fill part of the space between the casing and the surrounding earthen bore hole. However, grouting may not be necessary for driven or jetted wells.)

- About 62 percent of all individual wells (whether drilled, driven, dug, bored, or jetted) had adequate arrangements for sealing the wellhead from solid or liquid pollutants. Overall, sealing was adequate in a somewhat larger proportion of wellheads in the North Central than in the other regions.

- It appeared that potential pollution sources generally presented little threat to individual rural well systems. About 90 percent of individual wells were located more than sixteen meters (about 50 feet) from most potential pollution sources.

As to individual springs (for which engineering information was much more limited than for wells):

- The majority of the 275,000 individual rural springs used for major domestic water supplies were inadequately protected from contamination: reservoirs often had inadequate covers, the source tended to be inadequately shielded from pollution, and the spring pool itself tended to be subject to contamination which could be passed on to the domestic supply.

As to engineering features associated with individual cistern systems:

- Many of the 133,000 individual cistern systems used for major domestic water supplies in rural America appeared to be pollution prone. For example, nearly six of ten systems had no first-water diverter (to protect the supply from debris in incoming water). Then, cleaning drains were not installed in 76 percent of the systems. Finally, covers were unacceptable for excluding contamination in 30.4 percent of the systems.

As to engineering features associated with individual surface water systems:

- Of the 93,000 individual systems in rural America supplied by lakes, streams, ponds, and the like, about 41 percent had adequate source protection, and the balance had inadequate protection.

As to general source-to-household considerations for all 8.8 million individual systems (regardless of source or type of supply), major NSA findings were:

- In 91.0 percent of all individual systems, water was piped to the households by electric pump. Only 0.8 percent of supplies had hand pumps. Natural pressure (gravity flow or artesian pressure) provided the motive power in about 2 percent of systems. In 5.5 percent of all individual supplies, water was either transported in bulk to the household or else carried there by hand. Other methods, or unknown methods, were utilized in less than 1 percent of all systems. Whereas nearly all SMSA systems (about 98 percent) used pumps for transport to the household, other methods were employed for about 10 percent of nonSMSA systems. Propulsion by electric pump was the only method for bringing water into the house in large-rural-community systems.

- Among the various possible devices used to propel, pressurize, store, or treat water, the two devices found most frequently in individual systems were the water pump (in 92.5 percent of all systems) and the pressure tank (in 89.2 percent of all systems). As opposed to the pressure tanks, which enhanced the efficiency of power pumps, storage tanks were rare (in only 7.8 percent of systems). Among the various devices used to treat water, only the water softener (in 17.6 percent of systems) was used in more than a small percentage of systems. About 75 percent of all softeners in individual systems were in the North Central—a finding which was consistent with the discovery that the median water hardness value in the major supplies of the North Central was larger than for any other region (see Chapter V). Also, about 28 percent of SMSA individual systems had one water softener, but only about half that proportion of nonSMSA systems had softeners.

- Some type of free assistance or advice related to water systems was obtained for 22 percent of all individual systems. The most frequent type of assistance was free chemical or biological testing of the supply. Among the subnational findings, the most striking discovery was that nearly two-thirds of all large-rural-community systems had received some type of aid: this proportion was almost three times that for systems in other rural areas and sixteen times that for systems in small rural communities.

- Assistance or advice related to water systems were obtained most often from local or state agencies or health departments, from individuals, or from water softening companies. Assistance was rarely obtained from federal sources, stores, contractors, and local plumbing companies.

As to tests done professionally for water quality in individual systems:

- Approximately 37 percent of all rural households with individual systems had had the water tested at least once. In the South, however, water tests had been conducted in only 27.6 percent of the households—compared to at least 40 percent in each of the other three regions. Water quality testing also occurred somewhat more often in SMSA (43 percent) than in nonSMSA households (35 percent). In addition, testing was done much more often in large communities (44.4 percent) and in other rural areas (37.5 percent) than in small communities (20.2 percent).
- The frequency of testing varied considerably: in about 0.6 percent of all households in which testing had been done, the water had been tested 70 times or more, while in 83.5 percent, the water had been tested only once or twice.
- Nearly 70 percent of the most recent tests (that is, the last test performed in each household) were done during 1970-79.
- Two prominent reasons for testing were (1) to determine if a system alteration was needed (in 49.5 percent of all households testing) and (2) to check a newly installed system (in 26.2 percent of households testing).
- Tests of water quality most often were requested by members of the household (in about 58 percent of all households testing), and this was the prominent source of requests for testing regardless of the households' regional, SMSA versus nonSMSA, and size-of-place status.

- As to the specific type of the most recent test, bacteriological tests, either singly or in combination with chemical tests, were done in 53.0 percent of all households testing; chemical tests, either singly or in combination with bacteriological tests, were done in 38.8 percent of all households testing. The most prominent regional differences were in the Northeast, where the proportion of households with single or combined bacteriological tests was 68.6 percent, and in the South, where the proportion of single or combined chemical tests was only 23.3 percent.

- According to the verbal reports from household members, the levels of bacteria were within applicable standards at 52.3 percent of households at which the relevant tests were done: the levels exceeded the standards at 3.1 percent of the households; the results were not known at 44.5 percent of the households. Similarly, results of the chemical tests were unknown at about 64 percent of households at which the tests were done. At the households where the test results were known, 2 percent or less reported unacceptable levels of nitrate, sulfur, calcium, sodium, and arsenic, while 5.5 percent of these households reported unacceptable iron levels.

INTERMEDIATE SYSTEMS

The intermediate systems (those with two through fourteen connections) usually were centered at some rural household rather than at a separate facility. Intermediate systems thus were similar to individual systems rather than to community systems. On the other hand, intermediate systems potentially had some of the characteristics associated with community systems (those with more than fourteen connections). The NSA profile of intermediate systems thus was developed from data obtained at both the household and the system.

The order of presentation in this summary combines features of the individual-system summary, just completed, and features of the community-system summary, which follows. As is true in the summaries for individual and for community systems, only selected findings are given here. In particular, external engineering findings are omitted for intermediate systems which used springs or surface water since the source of that information must be qualified in some detail—a task beyond the scope of this summary. Furthermore, as was true for individual systems, external engineering features of intermediate systems using purchased water were not considered since the source could not be determined. As a result of these considerations, external engineering features are summarized here only for intermediate systems with wells.

As to findings related to overall features of all intermediate systems:

- Of the 845,000 intermediate systems serving rural America, the largest proportion (46.3 percent) was in the South (the regional distribution generally paralleled the regional distribution of rural households).
- About 91 percent of intermediate systems had only two or three connections. Larger intermediate systems (with four through fourteen connections) were uncommon, and were found more often in the Northeast (12.1 percent of intermediate systems there) and West (13.8 percent) than in the North Central (6.4 percent) and South (7.4 percent).
- About 80 percent of all intermediate systems had only one kilometer or less of distribution pipelines, and about 1 percent of systems metered service connections.
- Groundwater, primarily from wells rather than from springs, was used by 92.1 percent of intermediate systems. About 8 percent of intermediate systems used surface water, and about 1 percent used either precipitation or purchased water. Only about 1 percent of all intermediate systems had a combination of sources. The most striking subnational-data finding was that all systems serving households in either large or small rural communities used only groundwater.

- About 90 percent of intermediate systems were owned by individuals (one of many characteristics shared with individual systems). Despite the predominant individual ownership, there was some regional variation: cooperative ownership was reported by 12.9 percent of systems in the Northeast, compared to 2.5 percent of systems in the South. Ownership by private firm was reported by 8.1 percent of systems in the West, compared to no more than 1 percent of systems in each of the other regions.

- As to age (determined either by the number of years since original construction _or_ by the number of years since subsequent major alteration), the median for intermediate systems was seven years. Systems in the South tended to be newer than systems in other regions, and the median age of systems serving large-community households was only 1.8 years, compared to 7.3 years for systems serving other-rural-area households.

- For the 20 percent of intermediate systems which could provide the necessary information, the median average daily use (production) of water was 758 liters, or about 200 gallons, and the median maximum daily design capacity was 44,000 liters (11,609 gallons), nearly 60 times the median daily average production.

As to specific external engineering features of intermediate-system wells (examined at the household in the NSA, as for individual systems):

- About 88 percent of the intermediate systems relied on wells. An estimated 68 percent of the wellheads terminated above ground, generally under the protection of a structure such as a pumphouse. Only 39.0 percent of Northeast wells terminated above ground, however, compared to 78.5 percent of Southern wells.

- About 12 percent of intermediate wells were in pits, only about half of which had watertight covers. The well pit arrangement was most common in the Northeast, least common in the South.

- About 12 percent of intermediate wells were buried, and about 3 percent were located inside the dwelling unit.

- About 65 percent of all intermediate wells were drilled, and much smaller proportions were bored (8.9 percent) or dug (8.3 percent). Proportionately few wells were driven (3.0 percent) or jetted (2.1 percent), and the type of construction could not be determined for about 13 percent. Bored wells were most common in the South (in 16.8 percent of wells there), and dug wells were most common in the Northeast (in 17.2 percent of wells there).

- Median depth of intermediate wells for which information was available (about 85 percent of all wells) was about 28 meters (92 feet)—similar to the median depth for individual wells. The wells tended to be deepest in the West (a median depth of 38.5 meters, or about 126 feet), and shallowest in the North Central (a median depth of 23.9 meters, or about 78 feet). On the average, SMSA wells were deeper than nonSMSA wells: the median for SMSA wells was 38.2 meters (about 125 feet), compared to 29.8 meters (about 98 feet) for nonSMSA wells.

- Of the 683,000 drilled, driven, bored, or jetted intermediate wells, almost 40 percent were not grouted, 35 percent were grouted, and the grouting status of 25 percent could not be determined. These percentages are essentially the same as found for individual systems. Again, grouting may not be necessary for driven or jetted wells.

- According to three separate considerations explained in Chapter VII, arrangements for sealing wells against external contamination were adequate in two-thirds of all intermediate wells. The North Central had the highest proportion of wells judged acceptable for all three considerations (83.6 percent), the South had the lowest proportion (57.6 percent).

- Roughly 85 percent of all intermediate wells were more than sixteen meters (about 50 feet) from potential pollution sources.

As to general source-to-household considerations for all 845,000 intermediate systems (regardless of source), major NSA findings were:

- Most intermediate systems (about 91 percent) distributed water by electric pump. A relatively small number of systems (about 50,000) relied on gravity flow, and a few systems (about 3,000) used artesian pressure.
- As to treatment of the water, the supply in intermediate systems generally was untreated. Softening—the most common treatment process—occurred in only 6.0 percent of systems. Activated carbon or anthracite filters were installed and functioning in about 1 percent of intermediate systems. Only 2.8 percent of intermediate systems chlorinated the water, and the chlorination equipment was not operable at all of the systems which did chlorinate. Some type of treatment was practiced most often in the Northeast—at 15.4 percent of systems in that region. Comparable proportions were 10.0 percent in the South, 8.2 percent in the West, and 7.6 percent in the North Central.

As to manpower used to operate intermediate systems and system performance:

- About one-third of the systems had no equipment operators, and nearly half had only one operator. More than half of the intermediate systems in the North Central had no operators, compared to about one-quarter of systems in the South and West. Whereas more than half of systems serving large-community and small-community households had no operators, only about 34 percent of systems serving other-rural-area households were in this status.
- Of the 537,000 intermediate systems with operators, only 7,000 had operators who were paid, full-time employees. Most systems (84.6 percent) had at least one volunteer operator, who received no payment. Where the work was not done by volunteers, it most often was undertaken by paid, part-time operators.

- Since most systems with operators relied on volunteers, special training in the operation of system equipment was rare. Special training was reported for the operators at only about 3 percent of systems with one or more operators.

- Intermediate systems required little operation time: about 83 percent of all intermediate systems needed less than one man-day per month (less than eight hours).

- As to system performance, about three of every four intermediate systems reported no breakdowns during the year before the NSA. The breakdowns which did happen most often were attributed to pump malfunctions or to ruptured lines. Those systems reporting breakdowns usually had no more than two, but nearly all of the breakdowns were severe: that is, they resulted in loss of service to water users for more than six hours. The most prominent subnational finding was that systems serving households in other rural areas were more reliable than those serving households in communities. Specifically, nearly 76 percent of the former system had been free of breakdowns, compared to about 57 percent of systems serving small-community households and about 34 percent of systems serving large-community households.

- Only about 7 percent of intermediate systems in the nation had difficulty obtaining water from the source. As to further detail, fully 94.0 percent of groundwater systems had no difficulty, compared to 79.7 percent of surface-water systems—indicating greater reliability for groundwater.

As to water quality tests done at intermediate systems:

- Bacteriological testing was infrequent at intermediate systems; the testing was done at only 22.4 percent of all systems, and although the percentage rose to more than twice that in Western systems, testing was never done at systems serving large-community households. Of those systems that test, testing was done no more than once a year at about 61 percent of systems testing; 29 percent tested more frequently; and the frequency of testing could not be determined for an additional 10 percent.

- Most bacteriological tests for intermediate systems were done by state or local health departments, by state environmental departments, or by private laboratories.

- At the 131,000 intermediate systems which had performed bacteriological tests within a year of the NSA and which could provide test results, 91.1 percent had results which met prescribed levels for all tests (a maximum of twelve, as explained in Chapter VII), and 2.8 percent had results which met prescribed levels for more than 90 percent of the tests.

- Only 9.7 percent of intermediate systems conducted chemical and physical tests. The Northeast had the greatest proportion of intermediate systems performing chemical tests (23.9 percent), the North Central had the smallest proportion (4.6 percent).

- At nearly 60 percent of intermediate systems at which chemical or physical tests had been done, the tests had been performed during the preceding three years. The earliest year for testing was 1955, which may have been the year of original construction. Results for the tests were too few to assess in the NSA.

COMMUNITY SYSTEMS

In the NSA, community systems initially were defined as those which had fifteen or more service connections or which served more than 25 people. In Chapter VII, however, and in the NSA analysis generally, the definition was limited to systems which had fifteen or more service connections, since it was considered difficult for system representatives to report accurately on the number of people served by the systems.

The physical and economic configurations of the community systems were too complex to be conveyed by the one dimension of size, however. For this and other reasons, community systems were classified as either "independent" or "consolidated." The independent systems, which comprised nearly 90 percent of all community systems, were those self-contained systems which performed all functions associated with the provision of water. The independent system thus secured water from its own sources, treated the water, distributed it, and managed its own organizational and financial affairs.

The consolidated system, on the other hand, relied on interdependent links with other organizations. In one type of consolidated system, for example, the sets of facilities would be located far enough apart from each other to require local water supply arrangements, but the facilities would be considered components of a consolidated system if their management were accomplished within the overall structure of a water district or similar administrative body. In another type of consolidated system, one facility would purchase water from another organization —a situation which existed at nearly 90 percent of the approximately 4,000 consolidated systems.

In this summary, as in Chapter VII, the independent and consolidated systems are considered separately. The general order of presentation for each type of system is similar to that used for individual and intermediate systems. Details about supply-related engineering features are not addressed here or in the text, however. Such an analysis for community systems would have been beyond the scope of the NSA. Thus, overall organizational and physical features are described first. Then the discussion shifts immediately to overall technical, administrative, and water quality considerations.

As was true for the preceding summaries of findings for both individual and intermediate systems, the main focus here is on the national findings. Some references are made to regional, SMSA versus nonSMSA, and size-of-place findings, but considerable selectivity is necessary because of the diverse, qualified nature of many findings. Furthermore, no references are made to subnational findings regarding consolidated systems. Those findings are omitted from Chapter VII for reasons discussed in detail in the text.

INDEPENDENT SYSTEMS

As to findings related to overall features of independent systems:

- Of the 34,000 community systems serving rural households, nearly nine of ten were independent. The distribution of these systems generally paralleled the distribution of rural households; 80.5 percent of the systems served households outside of SMSAs; 74.5 percent of the systems served households in other rural areas; likewise, about 42 percent of the systems were in the South, 28 percent in the North Central, and so forth.

- The median number of independent-system connections was about 59 nationally. Regionally, however, medians ranged from about 30 for systems serving Western households through about 79 for systems serving North Central households. The size-of-place range was even greater—the medians ranged from about 37 for systems serving other-rural-area households through 544 for systems serving large-community households.

- Most independent systems had very limited distribution networks (which, in the NSA, included main pipelines but excluded service lines): 31.3 percent of all independent systems had only one kilometer (0.6 miles) or less of pipeline, and the national median length was 2.4 kilometers (1.5 miles). Again, the most notable discovery among the subnational findings was that systems serving large-community households had a median distribution line length of 15.3 kilometers (9.5 miles)—still limited in comparison to large urban systems, but relatively large in comparison to systems serving small rural communities or other rural areas.

- Groundwater was a source for about 90 percent of systems, surface water for about 12 percent (some systems used both sources, so the percentage is more than 100). The use of surface water was most prominent in systems serving households in the West (in 21.3 percent of those systems), systems serving households outside of SMSAs (in 12.7 percent of those systems), and systems serving large-community households (in 20.2 percent of those systems).

- Whereas individuals owned most of the individual and intermediate systems, public bodies owned about 37 percent of independent systems, and individuals owned about 31 percent. Independent systems serving Western households, however, were more often owned by individuals (42.9 percent of systems) than by public bodies (20.9 percent). Independent systems serving other-rural-area households also were more often owned by individuals (41.9 percent of systems) than by public bodies (18.7 percent of systems).

- Median age of independent community systems—as determined either by the number of years since original construction or by the number of years since subsequent major alteration of the systems—was only three years, less than half the median age of intermediate systems.

- The median average daily use (production) of water was about 136,000 liters (35,928 gallons) for those 19,000 independent systems for which information was available. The median maximum daily production capacity of independent systems was four times as large as the median average daily use, about 546,000 liters (144,000 gallons).

- The NSA results revealed a striking dichotomy in metering arrangements: in nearly half (48 percent) of all independent community systems, none of the connections were metered, while in a proportion nearly equivalent to the other half (46.7 percent), 95 percent or more of the connections were metered. (Lesser proportions were metered at about 5 percent of systems.)

- As to treatment processes, it was discovered that some type of treatment was employed at 60.6 percent of independent systems. Regionally, some treatment was done in nearly 71 percent of systems serving Southern households, but in only about 41 percent of systems serving Western households. The most decisive difference in the subnational findings was that treatment was used at 81.6 percent of systems serving small-community households, but only at 54.0 percent of systems serving other-rural-area households.

- Although chlorination was the most frequently used of various specific treatment processes, even chlorination was employed at only 57.5 percent of independent systems. Fluoridation, aeration, coagulation, and flocculation were used infrequently. Treatment was most prominent at independent systems which served large-community and small-community households. For example, chlorine was being added to the water at about 75 percent of those systems, but only at about 51 percent of systems serving other-rural-area households.

- As to manpower used to operate equipment at the systems, most independent systems (about 93 percent) had at least one operator, and nearly half had more than one operator. All of the systems serving households in the Northeast had operators, whereas some of the systems serving households in each of the other regions did not.

- Most independent systems with operators (85.7 percent) had at least one paid part-time or paid full-time operator, and only 25 percent had volunteer operators. In contrast, most intermediate systems (84.6 percent) had at least one volunteer.

- About 45 percent of all 30,000 independent community systems had at least one operator who had received special training or schooling in the operation of equipment at the system. Regionally, at least one operator had received special training at about 60 percent of all independent systems serving Northeast households, but only at about 27 percent of all independent systems serving Western households. At least one operator had received the training at 70.1 percent of all systems serving large-community households, compared to 42.8 percent of systems serving other-rural-area households.

- The monthly operation of about 69 percent of all independent community systems required at least one man-day of labor (equivalent to the work of one person during eight hours). The median for independent systems (excluding those for which information was not available) was 1.6 man-days per month. The most prominent subnational finding was that, in keeping with their larger operations, independent systems serving large-community households required the most labor time. Specifically, the median number of man-days per month was 18.3 at systems serving large-community households, 7.2 at systems serving small-community households, and 1.4 at systems serving other-rural-area households.

- As to system performance, about 55 percent of independent systems reported one or more breakdowns during the preceding year. The breakdowns were caused most often by pump malfunctions or ruptured lines. Although a few systems had numerous breakdowns, most had five or fewer. The incidence of breakdowns was particularly prominent among systems serving Southern households: roughly 72 percent of those systems reported one or more breakdowns during the preceding year.

- Of the approximately 16,000 independent systems with one or more breakdowns during the preceding year, about 11,000 (approximately 70 percent) reported that at least one of the breakdowns caused interruption of service to customers. Systems serving Northeast households were more likely than systems serving households elsewhere to have had service interruptions.

- The NSA results showed that 3,700 independent community systems (about 9 percent of all independent systems) sometimes had difficulties which interfered with acquisition of water from the source. A total of 3,000 of the 27,000 independent systems (11.1 percent) which used groundwater had such difficulties compared to 700 of the 3,000 systems (23.3 percent) which used surface water. In other words, by this measure, groundwater was about twice as reliable a source as was surface water.

As to water quality tests done at independent systems:

- Bacteriological testing was done at about 91 percent of independent community systems (27,400 systems) compared to only 22 percent of intermediate systems (189,000 systems). Bacteriological testing was done at a much smaller proportion of independent systems serving households in the West (74 percent) than elsewhere. Tests were performed at more than 93 percent of systems serving households in each of the other regions.

- Most bacteriological testing was done at least once every month. In contrast, most testing at intermediate systems was done irregularly or no more than once a year.

- In regard to organizations conducting the bacteriological tests, most independent systems relied on facilities outside of their own organizaitons, as was true for intermediate systems. Most tests for both independent and intermediate systems were done by state or local public health departments, by state environmental departments, or by private laboratories.

- At 23,000 (92.4 percent) of the 25,000 independent systems for which test results were available, all bacteriological tests (a maximum of twelve, as explained in Chapter VII) showed results which met the levels prescribed by regulations affecting the systems. At nearly all the rest of the systems (6.4 percent), more than 90 percent of the tests showed results which met those levels.

- About 54 percent of the systems (16,000) reported that chemical tests (including physical tests) were performed, but about 46 percent (14,000) reported either that chemical tests were not performed, or that it was not known whether tests were done. Chemical tests were performed more often in systems serving households in the Northeast than in other regions, and in systems serving households in large communities than households in small communities or other rural areas.

- At nearly 70 percent of the systems at which chemical tests had been done, the tests had been performed during the preceding two years. The indication of increased testing since 1975 was consistent with promulgation of the EPA's National Interim Primary Drinking Water Regulations on December 24, 1975. Although results of the most recent tests were obtained in the NSA, those results were not analyzed for this report for reasons outlined in Chapter VII.

CONSOLIDATED SYSTEMS

As to findings related to overall features of consolidated systems (national findings only):

- Although only about one of ten community systems was consolidated, the consolidated systems tended to be considerably larger than independent systems in terms of number of connections. The median number of connections for the 4,000 consolidated systems was about 153—two and one-half times the median number for independent systems.

- Excluding the 450 consolidated systems (11.3 percent) for which the information could not be obtained, the median length of consolidated-system distribution lines was about 4.3 kilometers (2.8 miles).

- By definition, as explained in Chapter VII, purchased water was by far the most common source for consolidated community systems (in about 88 percent of systems). About 11 percent of consolidated systems used more than one source of water.

- Consolidated systems most often were owned by a public body. In fact, proportionately more consolidated than independent systems (48.7 percent, compared to 36.8 percent) were owned by the public.

- The median age of consolidated systems—as determined either by the number of years since original construction or by the number of years since subsequent alteration of the system—was 5.5 years, compared to seven years for intermediate systems and three years for independent systems.

- In terms of water usage, the consolidated systems were only slightly larger than the independent systems. Median average daily use of water was about 162,000 liters (42,797 gallons) for consolidated systems, compared to 136,000 liters (35,928 gallons) at independent systems.

- About 74 percent of all consolidated systems, compared to only about 52 percent of independent systems, metered some connections. As was true for independent systems, most consolidated systems which did meter connections did so for 95 percent or more of the connections.

- Concerning treatment processes, only about 5 percent of consolidated systems (about 200) reported using untreated water. In contrast, nearly 40 percent of all independent community systems did not treat their water at all. The difference may in large part have been determined by treatment practices at the facilities which sold water within consolidated systems.

- Chlorination, the most frequently used treatment process, was utilized by about 92 percent of consolidated systems—compared to about 58 percent of independent systems.

- As to manpower requirements, about 96 percent of all consolidated systems had at least one equipment operator. Furthermore, about 79 percent of consolidated systems had two or more operators, compared to about 49 percent of independent systems and 16 percent of intermediate systems.

- The work status of operators in consolidated systems also indicated a more formal organizational arrangement than in independent or in intermediate systems. Only 2.4 percent of consolidated systems had volunteer operators, compared to about 25 percent of independent systems and 86 percent of intermediate systems. The balance of the consolidated systems had operators who were paid either part time or full time.

- Although a greater proportion of consolidated than independent systems had part-time or full-time operators, only about 41 percent of consolidated systems—compared to 45 percent of independent systems—had operators with special training or schooling in the operation of equipment.

- Consistent with the higher operational staffing level in consolidated versus independent systems, the consolidated systems required more labor time for their operation. Excluding the systems for which information was not available, the median man-days per month required to operate consolidated systems was 6.5—or four times the median for independent community systems.

- As to system performance, about 50 percent of consolidated community systems had breakdowns during the preceding year. This proportion was slightly smaller than for independent systems (55 percent), but still considerably greater than for intermediate systems (26 percent). The majority of consolidated systems which did have breakdowns had five or fewer. Ruptured lines and pump malfunctions were among the leading causes at consolidated systems, as they were at intermediate and independent systems. About 1,800 of the 2,000 consolidated systems which had breakdowns (about 88 percent) reported that at least one of the breakdowns resulted in loss of service to customers.

As to water quality tests done at independent systems:

- Bacteriological testing was done at essentially all consolidated systems. Also, testing was done more frequently at consolidated community systems than at other multiple-connection systems serving rural America. Testing at monthly intervals —or more frequently—was done at almost all consolidated systems which tested, at about 85 percent of independent systems which tested, and at about 15 percent of intermediate systems which tested.

- In terms of organizations conducting the tests, the majority of systems relied on state and local health departments and state environmental departments, as did both intermediate and independent systems. On the other hand, the proportion of consolidated systems using their own laboratories exclusively (11.4 percent) was larger than the proportion of independent systems (1.9 percent) or of intermediate systems (0.0 percent).

- At about 3,800 consolidated systems (96.1 percent of those performing tests), the results of all of the bacteriological tests met the prescribed levels. At nearly all the rest of the systems (3.4 percent), more than 90 percent of the tests had results which met the prescribed levels.

- Although essentially all consolidated systems tested for bacteriological water quality, about 15 percent did not test for chemical (or physical) water quality. In addition, it was not known whether chemical testing was done at 5.5 percent of systems. Most consolidated systems which tested for chemical water quality performed the tests within a year of the NSA survey. Results of the chemical tests were not analyzed in the NSA for reasons outlined in Chapter VII.

SUMMARY OF CHAPTER VIII

Potentially, there are a large number of attributes that may be used to characterize the economic conditions of water systems. The NSA compiled data on those aspects judged to be most important to the financial viability of the systems, and the results are presented in Chapter VIII. The subjects addressed include capital expenditures either for initial construction or for the most recent major alteration, the general and particular arrangements for the financing of these activities, revenues from water production, and operating and debt retirement expenses. Although the information about revenue and expenses is limited to dollar amounts, more detail is provided for financing arrangements. This detail consists of the source of the capital, the amount of funds acquired, the interest rate for the funds, and the length of repayment periods. As to the sources, information is provided about internal mechanisms, such as reserve funds or accumulations of surplus, and external modes of support, such as loans and grants from public entities, municipal bonds, and commercial loans. An effort also is made to establish the relative prominence of each source and the extent to which each subsidizes the operations of water systems serving rural America.

For a number of reasons, but most importantly the limited amount of information available to describe intermediate water systems, the economics of community systems are presented first, followed by similar data on intermediate systems. Because of the relatively small size of the NSA case base, no distinction is made between independent and consolidated community systems, a discrimination made in Chapter VII. For the same reason, the information is limited to the nation as a whole: subnational groupings are not considered.

COMMUNITY SYSTEMS

Construction costs, which varied substantially among community systems, ranged from a low of $90 to a high of $35 million when expressed in 1978 constant collars. (Construction costs were made either for original construction or for subsequent major alterations, as already noted.) Systems most often financed these activities with capital secured from internal sources (47.0 percent of systems), less often from external sources, (39.2 percent of systems), and least often from a combination of internal and external sources (9.7 percent of systems). Although community systems financed capital projects with internally generated funds, the amounts invested tended to be smaller, as was indicated by the median amount of $6,000, compared to much larger medians for capital from external sources, as noted below. When the systems had a larger requirement for capital, they were inclined to seek some external source. Of these external sources, loans from government agencies were most prevalent, followed by commercial loans, government agency grants, and municipal bonds.

Community systems that supported capital expenditures with loans and grants from public entities tended to receive them from some organization affiliated with the federal government. State agencies and other public bodies, such as special districts or water authorities, also were involved in providing loans to community water systems. Grants were made available by all these sources as well as by regional agencies. Of these federal organizations, the Farmers Home Administration (FmHA) was the most prominent source of loans and grants, followed by the Economic Development Administration (EDA). Some systems also secured loans or grants from the Department of Housing and Urban Development (HUD), and a few others received grants from the Department of Defense (DOD).

On the average, loans from HUD (mean of $609,000, median of $280,000) were the largest, followed by those from FmHA (mean of $288,000, median of $175,000), and EDA (mean of $228,000, median of $237,000). Generally, state agencies lent smaller amounts of funds in comparison to the other organizations from which community systems borrowed capital. Data on standardized rates indicated that systems with loans from FmHA paid a slightly higher mean interest rate than systems with loans from HUD or EDA, although a lower median interest rate. Another aspect of the situation was that a larger proportion of systems with FmHA loans were being subsidized (paying less annually than the value of the loan). At the other extreme, however, a higher percentage of other systems that had loans from FmHA appeared to be paying very high capital costs ($50 to $100 per every $100 of loan value).

Regarding grants, although they did not provide support to as many community systems, grants awarded by regional agencies tended to be for larger amounts than those received from the three federal agencies (FmHA, EDA, and HUD). Considering only these three organizations, grants from HUD (median of $164,000) and EDA (median of $159,000) were slightly larger than those obtained from FmHA (median of $105,000). Grants from regional agencies (median of $172,000) were larger overall than those acquired from the federal organizations, while grants from state agencies (median of $61,000) were the smallest.

Many community systems supported their capital projects by issuing bonds or securing loans from commercial establishments. The bonds tended to be issued for relatively large amounts, with some exceeding $10.0 million. Standardized interest rates were comparable to those for federal loans, but a smaller proportion of systems received the equivalent of a subsidy from the bond-holders (determined by an estimated discount rate which, in simplest terms, compensated for the fact that a dollar currently in hand had a greater present worth than one promised after a time lapse—such as after a bond matured). Commercial loans were smaller on the average, and the systems that obtained capital from this source also paid the highest interest rates.

One objective of the NSA was to determine the amount of water-related revenue obtained by systems. The revenues (which unintentionally may have included other income, such as from taxes) differed substantially among community systems. Systems which charged for water, and for which information was available, reported revenues as low as $400 a year and as high as $12.0 million (the median was $6,000 yearly). About 18 percent of the systems did not charge for water, and therefore they had no water-related revenues. Annual revenues could not be determined for a substantial proportion of the systems (about 15 percent).

While they varied appreciably, revenues were occasionally not sufficient to support all expenditures. Fully 10 percent of community systems received less in revenue than was allocated to the combination of operating and maintenance costs and debt retirement expenses. Operating and maintenance costs tended to be substantial, although 3 percent of the systems reported that no funds were expended to support these activities. Debt retirement expenses tended to be small since about 33 percent of the systems did not allocate any money for this cost. Consistent with the considerable size differences among these systems, some had annual operating and maintenance costs of $7.3 million, while others had debt obligations of $4.0 million. Most significantly, information on operating and maintenance costs was not available for about 37 percent of the community systems. Similarly, data on debt costs were not available for about 40 percent of the systems.

INTERMEDIATE SYSTEMS

Construction costs, which varied substantially across intermediate systems, ranged from a low of $20 to a high of $1.5 million when expressed in 1978 constant dollars. Average costs were about $5,100, while the median of the distribution centered on $1,400. Construction activity among intermediate systems was mainly financed through reserve funds (about 66 percent), although assistance was sometimes secured from an external source (6 percent), or a combination of internal and external sources (less than 1 percent). The source of financing could not be determined for the remaining 28 percent.

The amounts of capital invested from internal sources were not as wide-ranging when compared to construction costs without regard to the specific source of financing. These internal amounts, which are also expressed in 1978 constant dollars, ranged from a minimum of $20 through a maximum of $63,000. The median amount invested from internal sources was $1,200, while the average amount invested was about $2,100.

Among the 30,000 intermediate systems that received external monies for water system development, funds were most often secured from commercial establishments (about 60 percent), but were sometimes obtained from federal agencies in the form of loans (about 37 percent) or grants (about 3 percent). Commercial financing was modest in scale, ranging from $600 through about $15,000. The mean and median amounts borrowed from banks ($3,300 and $2,300, respectively) were somewhat larger than the comparable amounts invested from internal sources (see above). The amounts of funds secured from federal agencies were not detailed here or elsewhere, since only three intermediate systems appearing in the NSA sample were involved.

As to water-related revenues, the most significant finding was that fully 93.5 percent of all intermediate water systems did not charge for the provision of water. Those that did, reported revenues between $1 and $1,500, although only a few systems claimed revenues in excess of $100. Likewise, operation and maintenance costs rarely exceeded $100. However, a substantial proportion of systems (40 percent) which reported revenues indicated that, at least during the year preceding the NSA survey, no funds were expended to support operation and maintenance activities. Finally, few intermediate systems were retiring any debt. Among those that reported annual revenues, about 88 percent had no debt costs; 9

percent could not provide any information on this cost component; and for the few systems that allocated a proportion of annual revenues to debt retirement, small amounts were expended.

SUMMARY OF CHAPTER IX

The purpose of Chapter IX was to introduce the analytical segment of the NSA report. Each of the dimensions of status of rural drinking water was introduced along with the specific measures used in the analysis of each of these dimensions. A rationale was given to support the use of regression analysis for identifying independent variables which had an association with each of the dimensions of rural water supply. Finally, the structure of analysis was detailed.

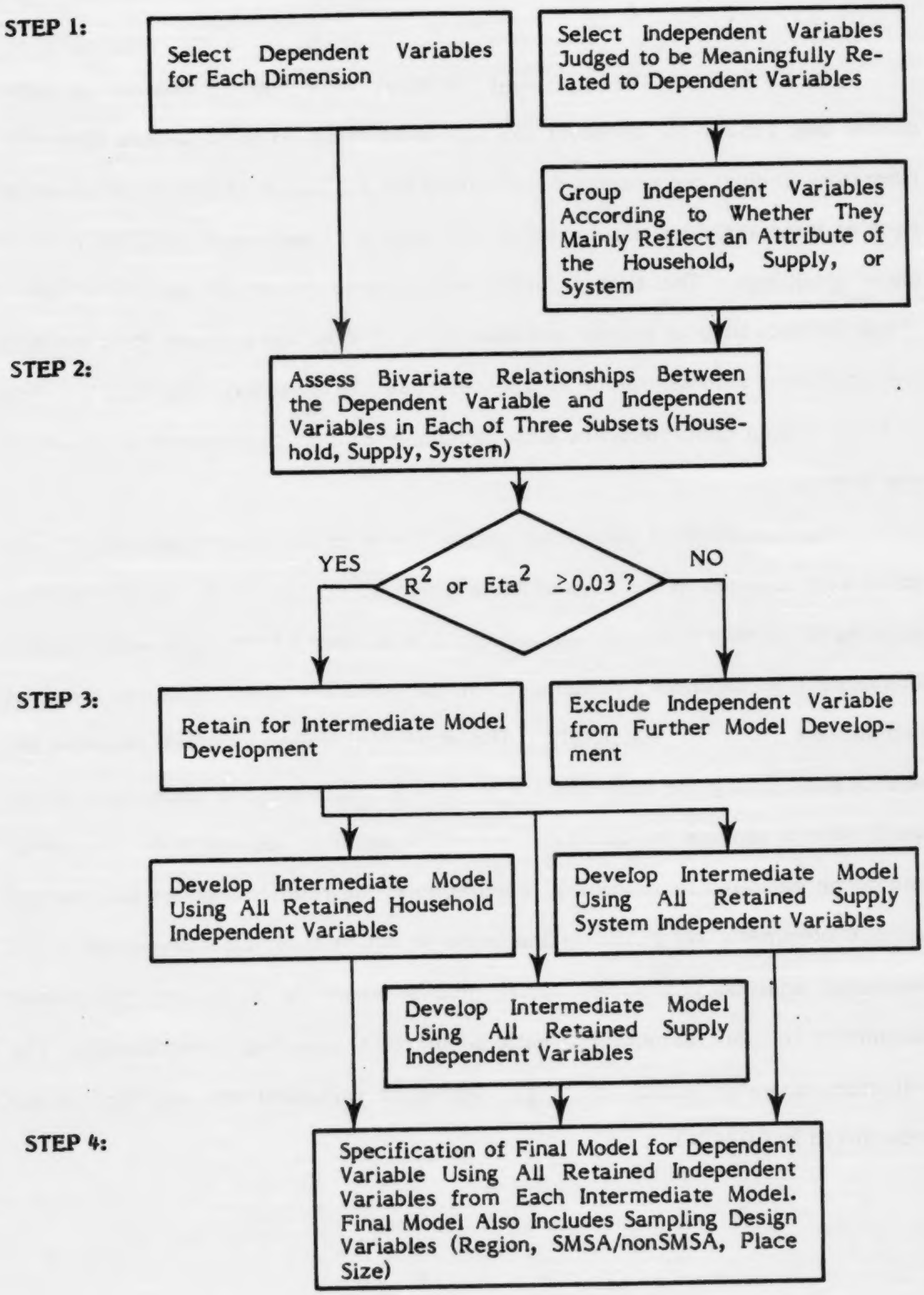
Several constraints and desired objectives for the analysis dictated the selection of multiple regression as the common analytical framework. Some of these constraints were: (1) wide range of content of the dependent variables, (2) complex phenomena encapsulated in the dependent variables, (3) irregularity of the distributions of some of the dependent variables, (4) use of several independent variables in modeling, (5) use of both categorical and continuous independent variables, (6) unequal number of cases in various categories of the independent variables, and (7) need for a standard, common analytical framework to ease communication of results.

As to the structure of analysis, independent variables were selected based on their expected relationships with the dependent variable under investigation. Bivariate relationships between the candidate independent variables and dependent variable were examined and interpretations made. Only those variables which met or exceeded the reference value used to determine analytical significance ($R^2 \geq 0.03$) were retained for intermediate model development. Intermediate models were constructed for the dependent variable with each of the three sets of independent variables—household characteristics, supply attributes, and system properties. The last stage of the analysis was to develop a final overall regression model which incorporated all the variables contained in the intermediate models and the variables used in the design of the NSA sampling frame (region, SMSA/non-SMSA, size of place). The stages of analysis are illustrated in Figure I-1.

In the case of quality, extended analyses were done on households served by wells and contingency tables were used to detail the conditions associated with total coliform contamination.

Figure I-1

Strategy for Analysis of Each Dependent Variable


STEP 1:
Select Dependent Variables for Each Dimension
Select Independent Variables Judged to be Meaningfully Related to Dependent Variables
Group Independent Variables According to Whether They Mainly Reflect an Attribute of the Household, Supply, or System
STEP 2:
Assess Bivariate Relationships Between the Dependent Variable and Independent Variables in Each of Three Subsets (Household, Supply, System)
YES
R^2 or Eta^2 ≥ 0.03 ?
NO
STEP 3:
Retain for Intermediate Model Development
Exclude Independent Variable from Further Model Development
Develop Intermediate Model Using All Retained Household Independent Variables
Develop Intermediate Model Using All Retained Supply System Independent Variables
Develop Intermediate Model Using All Retained Supply Independent Variables
STEP 4:
Specification of Final Model for Dependent Variable Using All Retained Independent Variables from Each Intermediate Model. Final Model Also Includes Sampling Design Variables (Region, SMSA/nonSMSA, Place Size)

SUMMARY OF CHAPTER X

In Chapter X, the dependent variables were eight indicators of water quality (see Table I-3). Seven of the dependent variables were derived from NSA laboratory findings and one was derived from the evaluation of household residents. Each of these variables was combined with selected independent variables in three major groupings. The first grouping encompassed household sociodemographic characteristics such as income and education. The second grouping took in supply characteristics such as type of supply and reliability of supply. The third grouping included system characteristics such as number of service connections and water test history.

The household, supply, and system characteristics (the independent variables) were selected on the basis of those which would potentially identify national patterns of widescale association between one or more of the eight water quality indicators (the dependent variables). In the summary which follows, the NSA findings are reviewed selectively. The statistical measures which describe the relationships among the variables are omitted in this summary, since there is not space here to provide the qualifications which would be necessary for interpretation of the indicated relationships. Furthermore, the relationships are summarized without systematic reference to the point at which they were developed in the three-step analytic procedure. Thus, this summary is limited to generalized statements relevant to potential national patterns regarding water quality. The indicators of water quality (the eight dependent variables) are addressed in the order listed in Table I-3.

Table I-3

Indicators of Household Water Quality

Household Water Quality Indicators	Description
Total coliform	Count of total coliform organisms per 100 milliliters in household water specimens
Nitrate-N	Measured level of nitrogen in the household water
Lead	Measured level of lead in the household water
Turbidity	Measured level of turbidity in household water
Aesthetic/economic indicator (Index 2 in Chapter VI)	Standardized combination of sulfates, iron, manganese, color, and total dissolved solids
Health-related indicator (Index 1 in Chapter VI)	Combination of the primary MCL-regulated contaminants: arsenic, barium, cadmium, chromium, mercury, selenium, silver, fluoride, gross alpha radiation, lindane, and methoxychlor, available for the 10 percent subsample of households
General water quality indicator (Index 3 in Chapter VI)	A gross measure of general water quality with standard scored contributions from total coliform, nitrate-N, sulfates, hardness, iron, manganese, sodium, lead, turbidity, color, total dissolved solids, arsenic, barium, cadmium, chromium, mercury, selenium, silver, fluoride, gross alpha radiation, gross beta radiation, lindane, and methoxychlor
Perceived water quality indicator (Perceived water quality index in Chapter VI)	A composite of household resident evaluations of the taste, odor, color, sediment, and clarity of the water supply

LABORATORY INDICATORS OF WATER QUALITY: REGRESSION ANALYSES

TOTAL COLIFORM ORGANISMS

The concentration of coliform organisms in rural supplies did not have a strong linear relationship with any particular household, supply, or system characteristic studied in the NSA analysis. The most useful independent variable appeared to be the type of household supply, which had a tendency to be associated with variation in coliform concentration. For purposes of the analysis in Chapters X through XIII, the household supply type was classified as community (served by a system with fifteen or more connections), well, or other (served by surface water, springs, cisterns, hauled, or purchased bottled water). The NSA findings showed that lower coliform concentrations generally were associated with community supplies rather than with wells, and lower with wells than with other types of supplies. In other words, the association indicated a greater potential for contamination in wells— and particularly in other supplies—than in community supplies. Similarly, the correlation between the number of connections (a system characteristic) and coliform concentrations suggested that the larger the system, the lower the concentration.

The lack of strong association among the variables was conditioned by the fact that so many household supplies were free of coliform organisms, or else had only one organism. By focusing on those households which had two or more coliform organisms per 100 milliliters of water (the NSA water quality reference value, as explained in Chapter V), it was possible to develop a tentative profile of households which tended to be most susceptible to potential contamination. Specifically, the profile suggested increased potential for contamination in households with: (1) heads having no more than a high school education, (2) total household income of less than $15,000 yearly, (3) supplies served by systems with fewer than 500 connections, (4) more than one treatment device, (5) less accessible supplies, and (6) long-term service from the supply (more than eight years). Across the nation, the NSA coliform reference value was exceeded at 28.9 percent of all rural households, but at 47.9 percent of households which had the six characteristics of the profile.

In considering the profile, it is essential to keep in mind that the features of the profile only help identify households in which bacteriological contamination might be more likely than in other households. The profile features do not, however, imply causality. For example, although the number of treatment devices is one profile feature, there is no indication in the NSA data that the devices themselves are associated with increased pollution potential—although such might be the case if, for example, one of the devices were a filter contaminated with bacteria. On the other hand, it may well be that households with pollution-prone source water are more likely to have several treatment devices, and that the water would be of even worse quality if the devices were not in use.

Among households served by wells which had fewer than fifteen connections, the only associations which proved useful for modeling were the well attributes. They included well type, grouting, splashproof cover, and well exit. The resulting final model for households served by wells related to total coliform contamination with an adjusted R^2 of only 0.17.

TURBIDITY

Levels of turbidity were not strongly associated with household, supply, or system variables. However, mean turbidity levels suggested that well supplies tended to be more susceptible to turbidity than did community or other supplies. At the same time, the standard deviation for turbidity levels in wells reiterated the finding that well turbidity levels varied greatly—from low to very high—across rural America.

The impression that community supplies tended to have the lowest turbidity was consistent with certain findings regarding the system variables.

Specifically, household supplies served by systems with fewer connections (such as single-connection individual systems) had a slight tendency to have greater turbidity. In addition, supplies served by privately owned systems (which often were individual wells) had the largest mean turbidity levels—a level which was nearly four times the mean level for supplies served by systems owned by the public or by private firms.

Among households served by wells, none of the considered variables demonstrated a systematic association with turbidity.

NITRATE-N

Concentrations of nitrate-N in rural household supplies showed very little association with household, supply, or system variables. This finding indicated that none of the specific variables—either alone or in combination—could be relied on as screening devices to identify households with nitrate-contaminated water supplies. The final linear regression analysis showed that regional variation in nitrate levels, reported in Chapter V, remained the only rough guide in the NSA to locating rural supplies prone to nitrate contamination.

For households using wells, the well type showed a weak association, the eta^2 equaling 0.03. No other considered variable showed a useful linear association with nitrate-N.

LEAD

As with concentrations of nitrate-N, concentrations of lead were not meaningfully associated with household, supply, or system variables. Thus, since lead contamination was fairly pervasive in rural America (see Chapter V), it was possible for the metal to affect domestic supplies regardless of type of household, supply, or system as classified in the NSA.

Among households using wells, three attributes of wells did show some association with lead levels. But, in a final model they combined for an R^2 of only 0.07.

AESTHETIC/ECONOMIC INDICATOR

The aesthetic/economic indicator (which is based on certain laboratory findings, and which is described in detail in Chapter VI as Index 2) showed no strong linear relationship with household, supply, or system variables. An examination of the mean values, however, did suggest that households which were willing to pay more for a better supply tended to have poorer aesthetic/economic indicator scores. This implied that household members sometimes perceived aesthetic or economic problems with the supply (in agreement with laboratory findings) and were willing to pay more for an improved supply.

A study of the mean values also indicated that the aesthetic/economic condition of well supplies was poorer than that of community or other supplies at rural households. Also, there was a slight tendency toward a less favorable condition in household supplies served by privately owned systems.

There was no indication of any systematic national association between the aesthetic/economic indicator and the considered variables among households served by wells.

HEALTH-RELATED INDICATOR

The health-related indicator (which is based on certain laboratory findings, and which is described in detail in Chapter VI as Index 1) showed no strong association with household, supply, or system variables. In fact, the associations were so weak that all of the independent variables were screened out in the first step of the analytic procedure, and linear association thus was not examined.

Among households served by wells, there were associations with the health-related composite. Well type, the number of connections, willingness to pay, total treatment, contamination distance, education, and well age were all variables sufficiently related to the composite to be included in the final regression model. In concert with the sample design variables, they registered an R^2 of 0.39 with the health-related composite.

GENERAL WATER QUALITY INDICATOR

Of the eight NSA water quality indicators, the most useful proved to be the general water quality indicator (which is based on laboratory findings related to a combination of aesthetic, economic, and health considerations, and which is described in detail in Chapter VI as Index 3). The final linear regression model showed that 27 percent of the variability of the indicator could be accounted for by certain household characteristics, one supply characteristic, and the sample design factors (the regional, SMSA/nonSMSA, and size-of-place groupings). The overall, three-step analysis showed that the most important associations occurred between the indicator and: (1) household willingness to pay more for a better supply, (2) the perceived relative cost of the water in the household, (3) household income, (4) the number of water treatment devices in the household, (5) supply accessibility, and (6) the regional location of the household.

Specifically, households which were willing to pay more for an improved supply tended to have the poorest quality water (on the basis of the indicator scores). As a corollary, a desire to pay less for the water tended to be expressed in households which had the best quality water. At the same time, the more costly the supply was perceived to be (on the basis of whether the supply cost was reported to be expensive, all right, or nonexistent), the better the quality tended to be. Household income appeared to have some association with variation in the indicator scores, but this independent variable was not as important as the other household variables. Finally, households with a larger number of treatment devices tended to have poorer quality water. (As noted before in the summary of findings for total coliform organisms, such a finding does not imply that the devices themselves in any way caused the poorer quality.)

Among the supply characteristics, accessibility, as measured by the accessibility index described in Chapter VI, showed some association with water quality. That is, the less accessible water supplies tended to provide poorer water quality. However, accessibility was too weakly associated to provide a reliable clue to anticipated water quality. Among the sample design factors, regional location was the most useful: water quality tended to be superior in Northeast households (as also reported in Chapter V).

A similar level of association was encountered for households using wells (R^2 of 0.25), but the contributing variables were substantially different. Most important was the type of well, followed by the reliability and the well exit variables.

The most useful variable among all the indicators of water quality for households served by wells was the well construction.

LABORATORY INDICATORS OF WATER QUALITY: CONTINGENCY TABLES

TOTAL COLIFORM ORGANISMS

Households served by community water supplies were above the NSA total coliform reference value at a rate of 15.5 percent, compared to those served by wells at 38.2 percent. Other supply types (hauled, springs, etc.) served households which were over the reference value in 77.7 percent of the cases.

Publicly owned systems served households which were found to be above the NSA total coliform reference value in 15.2 percent of the cases, compared to 19.3 percent of those served by systems owned by private firms and 40.6 percent for those owned by a private individual. Households served by privately owned systems were over six times more likely to be at or above 100 coliforms per 100 milliliters of water than those served by publicly owned systems.

Households which had higher incomes were less likely to have a total coliform problem (more than one coliform per 100 milliliters of water) than households with low income. Households which earned less than $10,000 per year were above the NSA total coliform reference value in 16.3 percent of the cases, as compared to 4.5 percent of households earning $30,000 or more per year. Under $10,000 income households served by wells were over the total coliform reference value at a rate of 44.3 percent, compared to 25.7 percent among the $30,000-plus income group. High income households had 7.5 percent, compared to 22.2 percent for low income households at the level of 100 or more coliforms per 100 milliliters of water.

Households where the head had less than a high school education were above the NSA total coliform reference value in about 15 percent more cases than among households where the head had more than a high school education. The low education households were at or above the count of 100 coliforms per 100 milliliters of water more than twice as often as the high education group. The relative pattern among education groups for households on wells was about the same as for the nation as a whole.

The more expensive rural residents perceived their water supply, the less likely they were to have a coliform problem. Over half (57.8 percent) of households where it was reported the water cost nothing were above the NSA total coliform reference value. Only 7.0 percent of households where the supply was reported to be very expensive were over the reference value. Among well users, 47.4 percent of those reporting no cost were over the reference value, as compared to 4.1 percent of those households which reported water costs as very expensive.

Households which were willing to pay more for an improved supply were more likely to be above the total coliform reference value than those wishing to pay less (32.2 percent, compared to 24.6 percent). Well users who were willing to pay more were over the reference value at a rate of 41.7 percent, compared to 30.5 percent among households willing to pay less.

Households served by supplies judged as poorly accessible were above the total coliform reference value in 59.9 percent of the cases. Those judged to have good accessibility were over the reference value in 23.2 percent of the cases. In terms of having counts of more than 100 coliforms per 100 milliliters, poorly accessible supplies were over four times more likely to be at that level than households served by supplies with good accessibility. Almost the same rate of over reference value households was found among well users as among all households with poorly accessible supplies (58.8 percent). A higher rate of wells judged to have good accessibility (37.5 percent) were over the reference value than all rural households judged to have supplies with good accessibility.

Renters were over the total coliform reference value among 47.3 percent of rural households on wells, while people who owned (or were buying) their home were over in 37.0 percent of the cases.

Households served by wells judged to be of poor or medium reliability were above the reference value in almost 49 percent of the cases, compared to 35.9 percent for those in the good reliability category.

Mobile home dwellers served by wells were over the reference value at a rate of 46.0 percent, compared to 37.1 percent for other well-served households.

Well-supplied households which did not treat the water were above the total coliform reference value at a rate of 52.5 percent. That problem rate declined to 32.6 percent for households using wells with three treatment devices. The rate climbed to 41.6 percent for those with four or more devices. The difference in source quality among categories was unknown.

While 40.2 percent of well-supplied households reported having tested the water at least once, their rate of exceeding the reference value, 36.0 percent, was close to the rate among households which had never tested, 39.7 percent.

Households using dug and bored wells exceeded the reference value most frequently among categories of well construction techniques (76.4 and 50.3 percent, respectively). Indeed, dug wells were over the high 100 coliform count level in almost half (48.5 percent) of the cases. Households on drilled and driven wells had the best records, but even they had a rate of exceeding the reference value on the order of 30 percent.

Knowing whether or not a well was grouted, in the absence of other information about its construction and condition, was not useful for discriminating rates of total coliform contamination among households on wells. Similarly, the age of the well did not account for much difference in rates of coliform problems.

Households on wells which either had a buried seal or a pitless adapter were over the total coliform reference value at about a 30 percent rate, compared to 45.0 percent for those on wells which had the water exit the well above ground level. This latter group was over twice as likely to have high (100-plus) total coliform counts.

The rates of total coliform problems were importantly different among well-using households depending upon the condition of the well cover. Cases where the cover was judged splashproof and otherwise adequate were over the reference value at 33.6 and 33.7 percent, respectively. On the other hand, cases where the cover was not splashproof, and inadequate in other ways, were over at rates of 57.1 and 54.4 percent, respectively. Similarly, households using adequately maintained wells were over the reference value at the rate of 35.3 percent, as opposed to 49.6 percent among those inadequately maintained.

Households on very shallow wells (3 meters or less) were over the reference value in 64.0 percent of the cases. Well depths from 30 to 60 meters showed a rate of 27.4 percent. Curiously, deeper wells had somewhat higher rates.

Households on wells which used public sewers were over the total coliform reference value at the rate of 23.9 percent. When wastewater was unconfined, that rate jumped to 53.2 percent.

Households served by supplies of all types which had all of three selected system characteristics (less than fifteen connections, privately owned, poorly accessible) were over the NSA total coliform reference value in 63.5 percent of the cases. Households served by systems with none of those attributes were over in 15.4 percent of the cases.

Total coliform problems among well-using households varied dramatically, based upon six selected well characteristics: the well was dug or bored, the water exited the casing above ground, the cover was not splashproof, the cover was generally inadequate, the maintenance was inadequate, the well was ten meters or less in depth. Households using wells with none of the selected attributes were over the total coliform reference value in 28.1 percent of the cases. The more of the attributes present, the greater the likelihood of a problem until the rate reached 77.4 percent when all six were present. When the list of attributes was enlarged to include four socioeconomic characteristics (less than $10,000 income, less than a high school education, mobile home, renting) and four supply and wastewater items (poor accessibility, medium or poor reliability, no treatment devices, uncontrolled wastewater), the results ranged from 21.4 percent among households with none of those characteristics to 94.3 precent when ten or more were present.

PERCEIVED WATER QUALITY INDICATOR

Before associations were tested between the perceived water quality indicator (described in Chapter VI as the perceived water quality index) and the independent variables, the indicator was checked for consistency with other household responses. The indicator was designed to reflect household perceptions about the combined intensity and duration of undesirable properties of odor, taste, lack of clarity, color, and sediment. Various correlations and comparisons indicated that respondents were consistent in the information which they provided to the NSA. In other words, the household respondents were able to focus their attention on the condition of the household supply and to give consistent responses about the nature of that supply. Furthermore, as another indication of the usefulness of the perceived water quality indicator, scores on that index tended to be consistent with scores on the aesthetic/economic index, which was based on certain relevant laboratory findings, as described previously.

As to relationships between the perceived water quality indicator and independent variables, only three variables among the household characteristics, and none among the supply or system characteristics, proved useful. Specifically, the indicator showed some association with willingness to pay more for the supply, age of the head of household, and length of residence. That is, there was a slight tendency for younger heads and for heads who had been in residence for shorter periods of time to have a poorer opinion of the quality of the water supply. The strongest association, however, was with the willingness to pay more for the supply. Residents who reported poorer quality water also tended to be more likely to be willing to pay more money for a better supply. This finding was consistent with the finding (reported above) that households which were willing to pay more for a better supply tended to have the poorest quality water as determined by the general water quality indicator based on a number of laboratory assessments.

SUMMARY OF CHAPTER XI

Two measures of quantity are assessed in Chapter XI. The first measure is the monthly quantity of water used in rural households, as calculated from household water bills. The second measure is of the NSA respondents' perception of the quantity of water usually provided by the household supply. The development of the two measures—called recorded quantity and perceived quantity, respectively—is described in Chapter V. As in Chapter X, a three-step procedure is used to identify potentially useful associations between the two dependent measures and selected independent variables. The independent variables are organized into three groups according to whether they are relevant to household, supply, or system characteristics.

RECORDED QUANTITY

Special conditions pertained to the development of the dependent variable representing recorded quantity. In brief (see Chapter V), both quantity of water consumed and the amount charged for water were available for only 567 of the 2,654 households surveyed in the NSA. Those 567 households were served by community systems, and they had sufficient billing information on which to base estimates about water consumption and cost. An additional consideration was that the quantity information itself had certain limitations. For example, data were recorded from only one water bill per household, so possible seasonal variation was not taken into account.

Overall, then, results of the NSA analysis were relevant only to a subset of sampled households, a subset which represented 5.4 million households across rural America (nearly 60 percent of all households which received water bills). As to the analytic findings relevant to those 5.4 million households, a total of five independent variables—four in the household-characteristics group and one in the system-characteristics group—had the minimum association with recorded quantity necessary for further analysis. As the analysis was completed, the most useful variables proved to be the four related to household characteristics—the unit cost of water, the number of household residents, the ratio of water charges to total household income (affordability), and the number of water-using fixtures and devices in the household. The one variable in the system-characteristics group—system ownership—was not as useful, and the emphasis thus was placed on the four household characteristics.

The strongest association was between the unit cost and the quantity consumed, with unit cost accounting for fully 22 percent of the screening-model variation in consumption. The unit cost was the cost in dollars per 1,000 gallons of water, but to ascertain the nature of its relationship to consumption, it was necessary to transform dollar amounts into the natural log of dollars. This transformation made it possible to perform the necessary linear regression analysis, but it meant that interpretation had to be stated in corresponding terms. Specifically, a unit increase in price (natural log of dollars) resulted in a decrease in demand of 13,911 liters (3,672 gallons) per month.

Although the effect of unit cost was pronounced, the exact influence of cost could not be ascertained because the effect of various pricing strategies (ranging from decreasing block rates to uniform rates) could not be incorporated into the variable representing the unit cost of water. Instead, it was necessary to assume a uniform set of charges by which water was priced at a constant rate for every thousand gallons consumed.

After unit cost, the number of household residents showed the strongest relationship to recorded quantity. As would be expected, household consumption increased a certain amount with each additional occupant. Consumption also was affected, to a lesser extent, by the ratio of water charges to total household income. Since this ratio was a measure of affordability, as explained in Chapter V, one might anticipate that as the ratio increased, consumption would decline. However, the opposite was true. That is, consumption actually increased as water charges took up a greater proportion of household income. This positive relationship suggested that families which allocated larger proportions of their budgets to water use were families which used more water. One possible explanation for this situation was that the cost-to-income ratio actually represented the consumer's willingness to pay for water, rather than a constraint imposed by a fixed budget. As to the fourth independent variable (the number of water-using fixtures and devices), water use increased moderately with each additional device, although with twelve or more devices, water use declined.

PERCEIVED QUANTITY

The dependent variable representing perceived quantity was developed from information about peoples' beliefs about the volume of water readily provided by the household supply. In Chapter V, this information was coordinated in a five-category scale. However, as reported there, about eight of every ten rural households reported having ample supplies, and only two of every ten reported some deficiency in the supply. Thus, in Chapter XI, because there was so little variability in the distribution of perceived quantity values, the scale scores were collapsed into two groups: in one group were all households where the supply quantity was reported to be completely satisfactory; in the other group were all households in which the supply quantity was in some measure deficient.

As to the analytic results, only one independent variable had an association with perceived quantity which was above the screening level. The variable, which was in the group of supply characteristics, represented the type of well supply. Specifically, dug wells more often were associated with insufficient quantity than were drilled, driven, jetted, or bored wells.

SUMMARY OF CHAPTER XII

Two indices which quantify the concept of availability are assessed in Chapter XII. The indices—representing accessibility and reliability—are described in detail in Chapter VI. In Chapter XII, however, the accessibility index is altered slightly, and certain modifications are made to counteract the effect of the unusual distributional properties of the reliability index.

The analytic procedure is the same as that used in Chapters X and XI. That is, relationships between the two indices and selected independent variables are assessed in a three-step process which is designed to identify factors which could account for variation in the indices. The independent variables are organized into three groups according to whether they are relevant to household, supply, or system characteristics.

ACCESSIBILITY

In the first step of the accessibility analysis, a total of ten independent variables—five in the household-characteristics group, four in the supply-characteristics group, and one in the system-characteristics group—had the minimum association with accessibility required for inclusion in the second step of the analysis. In the second step, the list of independent variables was reduced to nine, since one did not contribute appreciably to the explanation of variability in the accessibility index.

Although the nine independent variables, plus design-effect variables (for classification by region, SMSA/nonSMSA, and size of place), were included in the final linear regression model (step three of the analysis), the model did not prove to be more effective than the intermediate model for association of supply characteristics. That is, the intermediate supply model had about the same degree of explanatory ability as the final model, and it had the advantage of focusing on three key independent variables which were associated with accessibility. Those variables were: the type of conveyance by which water was transported from the source to the household (pressurized public supply, electric pump, or other method such as gravity flow or hand-carrying), the total number of treatment devices in the supply and system which served it, and the type of supply (community, well, or other). These three variables, combined, explained 52 percent of the variability in the accessibility index—compared to 54 percent of the variability which was explained by combining all of the variables in the final model.

The association between each of the three supply characteristics and accessibility was consistent with the nature of the variables involved. That is, accessibility in the NSA was determined by the distance over which water was transported and by the supply pressure. Thus, it was not surprising to discover that the most useful explanatory variable was conveyance—with water most accessible at households served by pressurized public supplies, less accessible at households served by individual or intermediate systems with electric pumps, and least accessible at households served by other types of supply. The next most useful explanatory variable was the type of supply—with water most accessible at households served by community supplies, less accessible at households served by wells, and least accessible at households served by other types of supply. Finally, the variable with the weakest association was the total number of treatment devices in the supply and system serving the supply—with water more accessible where there were more devices.

RELIABILITY

In contrast to the accessibility analysis, the reliability analysis uncovered no characteristics which had sufficient association to meet the screening level criterion. Thus, analysis of the correlates of reliability (based on the frequency of breakdowns and supply interruptions) did not proceed past the initial procedural step.

SUMMARY OF CHAPTER XIII

Two measures of cost are assessed in Chapter XIII. The first measure is the monthly cost of water to rural households across the nation. The second measure is the cost of every thousand gallons of water consumed at rural households. The detailed discussion of the two measures of cost appears in Chapter V. As in previous chapters, a variety of relationships are explored between the two dependent measures and independent variables organized according to whether they represent household, supply, or system characteristics.

Similar to the restrictions imposed on the analysis of the quantity of water consumed at rural households (see Chapter XI), the cost analysis was also restricted to households that were served by community systems and that received a bill for services. Even when a water bill was available, the necessary information was not always included on the bill. Hence, not all households served by community systems were represented in the analysis presented herein. The subset data actually represented 5.4 million rural households—about 60 percent of all households which reported receiving a regular water billing.

MONTHLY COST

The analysis pertinent to the 5.4 million rural households revealed the importance of the household set of attributes in estimating monthly water costs. More specifically, although the amount of water consumed during a month was the single most important factor in predicting monthly water expenditures, other household attributes of importance included the number of household occupants, the number of years served by the water system, the education of the household head, and the respondent's perceptions concerning the cost of the water supply. With the exception of the length of time served by the water system, all of the important household attributes showed a positive association with monthly water costs. That is, higher monthly water costs were associated with more of the attribute. A different pattern was evidenced between water costs and the number of years served by the present water supply system: monthly expenditures were lower in households served for longer periods of time. Perhaps this relationship was driven by the age of rural dwellers, since there is some evidence to support diminished water consumption among the elderly.

The analysis of monthly water costs identified one other variable which had an association with the dependent measure. The variable, which was in the group water system attributes, reflected the type of system ownership. Specifically, private firms were more often associated with higher monthly water costs, while public bodies were more often associated with lower costs.

UNIT COST

A similar set of factors emerged from the analysis of unit water costs. The volume of water consumed, as well as the respondent's perceptions about the cost of the supply, were identified as important correlates of unit water costs. While higher perceived costs were linked with higher unit costs, water consumption and the unit cost of water were inversely related, indicating that higher unit costs resulted in reduced consumption.

In addition to the household set of attributes, two variables in the water system group were important in determining per thousand gallon costs. The first corroborated the "economies of scale" theory which states that the cost of water is lower among households supplied by water systems larger in size. Here, the size of the system was evaluated in terms of the number of service connections. Secondly, the source from which the water was withdrawn had a bearing on the unit cost of water. Households which purchased water from systems using a groundwater source paid considerably less per unit of water consumed than those purchasing from systems which withdrew from a surface source.

II

Introduction

This report is the culmination of the first nationwide research study of rural household water conditions in the United States. The findings come at a time of renewed concern about the nation's water resources and, in particular, about the condition of its drinking water.

When the research was mandated by Congress in the Safe Drinking Water Act of 1974, existing information about rural water conditions was incomplete but disturbing. For instance, the 1970 census had determined that there were 1.2 million housing units in the US that did not have piped water, and 91 percent of them were located in rural areas. Separate studies conducted by federal and state agencies indicated problems of water quality in both individual wells and community water supplies in many parts of the country.[1] Among community systems, smaller systems (which were disproportionately located in rural areas) seemed more susceptible to water quality problems than larger ones.[2] The cost of water to rural households was likely to be higher than the cost to urban households, since operating expenses had been found to be higher for community systems which served fewer than 2,500 people.[3] In addition, many community systems across the US were believed to be deficient in water treatment practices and operator training. In short, many aspects of US water supply showed potentially serious problems and rural areas seemed to be most affected, but comprehensive information was lacking.

Since 1974, problems of continuing pollution, increased usage and conflicting demands on water, and the threat of at least localized water shortages have received public recognition. These issues will need to be addressed in the 1980s, and solutions will depend on accurate and complete information. This study provides data on many aspects of household water conditions in the rural US. It further strives to contribute to an understanding of the stresses that are particular to rural water supply by describing the nature and condition of the supply systems serving these households.

SCOPE OF THE NSA

The NSA's general orientation to the subject of rural water supply was established by the Safe Drinking Water Act of 1974. Although the subject of the legislation was more extensive, the particular section that called for a national study of drinking water supplies read as follows:

> Sec. 3(a). The Administrator of the Environmental Protection Agency shall (after consultation with the Secretary of Agriculture and the several States) enter into arrangements with public or private entities as may be appropriate to conduct a survey of the quantity, quality and availability of rural drinking water supplies. Such survey shall include, but not be limited to, the consideration of the number of residents in each rural area—
>
> (1) presently being inadequately served by a public or private drinking water supply system, or by an individual home drinking water supply system;
>
> (2) presently having limited or otherwise inadequate access to drinking water;
>
> (3) who, due to the absence or inadequacy of a drinking water supply system, are exposed to an increased health hazard; and

> (4) who have experienced incidents of chronic or acute illness, which may be attributed to the absence or inadequacy of a drinking water supply system.
>
> — P.L. 93-523
> December 16, 1974

Specific in the legislation were several key factors of water supply which were to be studied: quantity, quality, availability, and the health hazards related to inadequacies of water supplies with regard to these factors. Implicit in the concepts of quantity and availability were the additional factors of the cost of drinking water supplies and the affordability of those supplies.

The approach taken for addressing all the concerns of the legislation was that of a nationwide household survey. The boundaries of the survey were set to conform to the US Census Bureau's definition of "rural": households in incorporated and unincorporated communities with populations of less than 2,500, and rural households in areas not designated as places (households in other rural areas).

Four considerations shaped the basic design of the survey. First, the range of issues inherent in the list of key factors of water supply meant that social, economic, and institutional aspects of rural water supply, not only physical and technical aspects related to water quality, needed to be addressed. Household water reflects the ability of people—individuals, community supply systems, and government agencies of various kinds—to provide safe drinking water in adequate quantity and at affordable cost. The NSA thus had to examine the social interactions that surround rural water supplies. Many of these issues required information that could be gathered only at rural households.

Second, the major concern of the legislative mandate was the status of household water at the point of use rather than at the point of treatment or at the source. In fact, household water quality can be assessed accurately only at the household. Source water does not necessarily reflect the quality of the water that eventually reaches the household tap. Water supplies of all kinds are the result of many operations being performed on source water—extraction, treatment, distribution. The physical facilities for performing these operations may be quite simple or quite complex. In short, between the source and the household, many influences may affect water quality, so that the NSA could not rely on a survey of source water—of groundwater, lakes, streams, and the like—to draw conclusions about household water conditions.

Likewise, water quality measured at a community system's treatment plant might be quite different from what it would be if measured at the household. After it leaves the treatment plant, water may be affected by contamination through inadvertent cross-connections in the distribution system, or by other factors such as household plumbing and various water supply equipment at the household. The many influences on household water were recognized in the interim primary federal drinking water regulations established by EPA, which require most water quality standards to be met at the consumer's tap rather than just at the supply facility.

The third consideration affecting the survey design was the knowledge that almost half of all rural households had their own individual water supplies rather than being served by multiple-connection systems. A survey restricted to households using community systems would have excluded nearly half of the rural population. Consequently, the survey had to be based on a sample of all rural households.

The fourth consideration in the survey design was that water supply systems are intrinsic to the provision of household water, and that the survey would have to study supply systems of all kinds and sizes serving rural households. To meet this requirement, a companion study was included in the survey design which examined many attributes of supply systems. The system study included a physical inspection of water supply facilities at rural households. It also included separate interviews with system owners, managers, and operators for all households served by multiple-connection systems. This dual approach of surveying both households and systems represented a significant innovation. Previous water studies had focused primarily on source water or on municipal or rural community supply systems, disregarding the point of use, the household.

Thus, the study responding to the Safe Drinking Water Act was broader in scope than the focus of the rest of the legislation. The main intent of the Safe Drinking Water Act, which was an amendment to the Public Health Service Act (P.L. 410), was to improve drinking water supplies throughout the nation by imposing stricter water quality standards that would be enforced through the authority of the individual states. The standards were applicable only to public water supply systems, which subsequently were defined by the federal government as publicly or privately owned systems which had fifteen or more service connections, or which served 25 or more people daily at least 60 days out of the year. The scope of the NSA, on the other hand—rural household water conditions—had to include all rural households, whether they were served by individual or multiple-connection supply systems.

In many respects, the NSA sought a new dimension of knowledge about household water conditions. It became a multifaceted study that included economic, social, and technological factors of water supply in addition to an assessment of household water quality. Its objective was to provide a comprehensive description of rural household water conditions and an exploration of major factors associated with variation in those conditions.

The parameters of the NSA made it unique from all prior research on the subject of rural water. Implied in those parameters, however, were certain limitations. For example, the NSA was not designed to be a study of water as it exists in nature. It was neither a hydrological study nor a water pollution study. Perhaps the most distinctive feature of the NSA was its focus on water as it exists in rural households and as it is consumed, after all the influences relative to source, treatment, distribution, and household plumbing have made their cumulative effect. This focus is very unusual; most water quality studies focus on water in its natural state or on the production of consumable water.

Comprehensiveness was another unique feature of the NSA. Water quality was examined, of course, but so were conditions related to quantity, availability, cost, and affordability. In performing this broad survey, the NSA also examined physical aspects of water supplies, socioeconomic characteristics of rural Americans, and many other things which were thought to have a potential impact on the full range of household water conditions. The result is an integrated picture of water conditions in rural households, and an identification of the diverse factors which seem related to those conditions. (It should be remembered, by the way, that the NSA, like any survey, can draw out statistical associations, but cannot establish cause and effect relationships to explain those conditions.)

For some, the boundaries of the NSA may seem disappointing. Specifically, it might be hoped that the NSA could not only describe rural water supplies in terms of specific water quality constituents, but also explain why the constituents were present in particular supplies. Unfortunately, the NSA was not designed to do this. To conduct such an analysis would require geologic and hydrologic information—for instance, information from quality testing of aquifers, surface sources, and test wells situated at different depths. Also required would be information about the construction of wells, springs, cisterns, and so forth; the age and condition of household plumbing; and the presence of such things as galvanized piping from the pump to the household. Water would have to be sampled at various points along the distribution line and even at various points within a house. For the most part, this kind of information was not gathered in the NSA.

Nonetheless, a study that did provide such information would have its own shortcomings. For example, it would not necessarily have the power to predict which households were most likely to have water supply problems. The NSA can do just this. With its range of socioeconomic and other variables, the NSA can target in a general way the populations that are potentially in need of attention or assistance. (Corrective actions would, in any case, need to be based on more specific and timely data than either kind of study could offer.)

In short, the NSA is not the definitive study of rural water conditions, in spite of its size and complexity. But the NSA does provide a comprehensive survey of rural water conditions which has so far been lacking, and provides necessary data for further investigation of the subject.

COMPONENTS OF RURAL WATER SUPPLY

Several concepts crucial to an understanding of rural water conditions were difficult to delineate in the NSA because previous terminology was not distinct. Consequently, more precise definitions were developed for the terms "water source," "water supply," and "water system." When clearly distinguished, these terms were seen to constitute the basic components of water supply. These components were the source of the water, the physical facilities used to collect and transport the water to the household, and the socioeconomic characteristics of the system—its size, age, ownership, financing, and regulation. More complete definitions of these terms follow.

SOURCE

The term "source" was used in the NSA to designate any physical aggregation of water as it exists prior to human manipulation. Drinking water can originate in any one of three basic sources: groundwater, surface water, and precipitation.

SUPPLY

The NSA defined "water supply" as the set of facilities by which water is extracted from the source, treated, and transported to the household tap. "Water supply" also was used to refer to the water itself as it was taken from the household tap. A water supply, then, could be the facilities of a public or private organization which provided water from various sources to a number of households, such as a community supply. On the other hand, a supply could be some physical arrangement consisting of a pump, pressure tank, conditioning equipment, and a network of pipes that delivered water obtained from a well, spring, surface water source, or cistern. Other types of water supplies were hauled water and purchased bottled water (the latter sold by a commercial distributor either in small containers or in bulk). The NSA investigated all types and combinations of supplies providing water to rural households.

Drinking Water Supply and Major Household Supply. While the typical rural household obtained water from a single supply, it was anticipated when the study was designed that some households would be served by more than one supply of water. To meet this possibility, the study distinguished, where necessary, a household's major water supply from its drinking water supply. The major supply was defined as the one that satisfied most of the household's needs, while the drinking water supply was the one used primarily for drinking and culinary needs.

Even though drinking water does not account for very much of the volume of water demanded at most households, it constitutes a critically important domestic use, and the one which generally requires the highest quality water. The basis for the decision to examine the major household supply was an assumption that the household residents would use it for drinking if they perceived it to be fully adequate. A more fundamental reason for focusing the NSA on the major household supply was to avoid a possible misrepresentation of household water conditions. More specifically, a study that focused strictly on drinking water would not have detected certain unsatisfactory situations—for instance, one where household residents had to haul or purchase a few gallons of drinking water each week because the water from the major supply was not suitable for human consumption.

To avoid such a misrepresentation, the NSA determined the type of supply that a household used for drinking, and also determined what supply served as the major household supply. The latter supply became the major focus of study. Data gathered in the NSA household interviews and the water quality assays thus had the major household water supply as the subject, whether or not that supply was used for drinking. (In all but 3 percent of households, however, the major household supply was the same as the drinking water supply.)

Uses of Household Water Supplies. Although the NSA accumulated data to construct a profile of the ways rural households used their major household water supply, which ordinarily provided the household's drinking water, it focused largely on domestic uses. The term "uses" simply referred to the many purposes—domestic, recreational, commercial, and agricultural—for which water was typically employed. These, of course, could vary a great deal depending in part on occupational, economic, and geographic considerations. To distinguish more precisely some uses from others in the spectrum, uses were classified broadly according to whether they were initiated inside or outside of the household.

SYSTEM

The NSA reserved the word "system" to refer to the social and organizational aspects of water supply. These aspects differ markedly depending on system size. Consequently, the NSA used size as the criterion for classifying systems for descriptive and analytic purposes. Instead of adhering to the strict regulatory definitions of system size, which were necessarily complex, the NSA classified systems primarily on the basis of the number of connections served:

- — individual systems, which served a single household;
- — intermediate systems, which had from two through fourteen connections;
- — community systems, which had fifteen or more connections; this size category roughly conformed to the "community" system regulated by the federal government.

The NSA investigated many physical and organizational features of water supply and supply systems which have been shown or suggested to be important to providing water of good quality in sufficient quantity and at reasonable cost. Some of the features studied were common to all sizes and types of systems; others were unique to a particular type of supply.

Common to all sizes and types of supply systems were the characteristics of source of water; age since the supply was constructed (or last altered significantly); ownership of the system; size of system; type of construction; adequacy of protection of the source from intrusion by animals, plants, and pollutants; the means by which water is transported from the supply to the household; the extent to which the owner or operator of the system has received assistance in maintenance and operation of the system; the nature and extent of water quality testing; and the nature and extent of treatment. Financial arrangements and the extent of regulation vary a great deal, of course, in relation to a system's size, so these factors also were examined.

The NSA collected additional information when a household's major water supply was located on the premises—that is, at households with individual supplies. If the household used a well, the casing diameter of the well, the presence of grouting, the adequacy of the well cover, and the proximity of the well to visible sources of pollution were investigated. If the household used a cistern, the cistern was examined for the presence of a functional cleaning drain and first-water diverter, and for the location and protection of the catchment area.

When a household was served by a system having two or more connections, the interviewer asked a representative of the system about the number of metered connections, the system's design capacity, the average daily usage, and also about the number and training of system operators. An extensive comparison of these features was made for systems of different size and organizational complexity. Further, these characteristics were examined as possible explanatory correlates of variation in quality, quantity, availability, potential health hazards, and cost of water delivered to rural households.

NSA researchers believed that individual systems would show distinct characteristics and perhaps particular problems. They speculated that intermediate systems—two- and three-connection systems and various other, often informal, arrangements—would be indistinguishable in many respects from individual systems, but might sometimes share a few characteristics with community systems. It was especially important to find out what water conditions were like in intermediate systems, which are too small to be included in the legal enforcement limits of many regulations but which nonetheless bear a responsibility to the small segments of the public they serve.

Systems within the largest size category, community systems, were further classified into "independent" and "consolidated" systems. The distinction between these two types of community systems was based on whether or not a system's physical components corresponded to its organizational structure. Community systems that showed this correspondence were referred to as independent systems, while those that were not were designated as consolidated systems.

THE MAJOR DIMENSIONS OF RURAL WATER SUPPLY

The NSA was designed to provide a comprehensive assessment of rural household water conditions by examining water supply along six major dimensions:

quantity, quality, availability, potential health hazards, cost, and affordability. These six factors are outlined below.

QUANTITY

In the NSA, this term was interpreted as the amount of water that households were able to obtain from a water supply. Quantity was measured using consumption information on water bills, when available, or by assessing physical capacities of certain water supply equipment. Quantity was also assessed subjectively, by asking respondents to evaluate the quantity of water received from the household supply.

QUALITY

The NSA examined water quality in two ways. Quality was determined in part by laboratory assessment of physical and chemical properties of the water, such as the presence of constituents like bacteria, inorganic and organic substances, and radionuclides. These constituents were considered to have implications for health, economics, or aesthetic acceptability of the water. Also, predominantly aesthetic aspects of water such as color, odor, and taste were examined, since people's perceptions of these characteristics reflected their judgments of overall water quality. Such perceptions supplemented laboratory measurements of water quality indicators, and provided possible explanations of people's preferences for certain water supplies and the reasons why the major household supply was or was not used for drinking.

AVAILABILITY

Availability was assessed in terms of its two components, accessibility and reliability. Accessibility referred to the ease with which a household obtained its major water supply, given any limiting factors such as physical limitations of equipment, the distance from the household to the source, water pressure, and seasonal variations in the amount of water provided by the source. Reliability was measured by the number of breakdowns that had occurred in the household water supply during the year prior to the NSA.

POTENTIAL HEALTH HAZARDS

Health effects associated with rural drinking water supplies would most accurately be assessed by a long-term clinical study, which was beyond the scope of the NSA. Without incorporating such a clinical study, the NSA could not draw causal links between a household's water supply and specific incidents of illness that the household may have reported. Still, the NSA was able to address Congressional concern about the issue in two other ways.

First, the NSA determined whether the residents of rural households or any visitors had experienced any illnesses in the previous year which they thought were caused by drinking the household water supply. Of course, responses to this question were evaluated very cautiously, since residents may have underestimated or overestimated the incidence of illnesses related to the water supply. For example, it is difficult for people to assess the likelihood of particular illnesses stemming from a problem in the water supply. That is, people may overlook the water supply and attribute illnesses to an assortment of other factors instead. Conversely, if they suspect that the water supply has a quality problem, they may incorrectly attribute illnesses to it when the water supply is, in fact, not responsible. In some instances, however, people's perceptions do have some validity—for example, the perception that high levels of sulfates in a water supply may have adverse health effects for some people. In any event, it was important for the NSA to find out people's beliefs regarding this aspect of water quality.

The second way the NSA assessed potential health hazards was to assess household water supplies for levels of various constituents thought to be related to health effects. Beyond this, the NSA looked for correspondence between illnesses reported at specific households and constituent levels found in those households' water supplies. However, the statistical links could not demonstrate causality. Because of the limited information which could be produced by the NSA on health effects, analysis, and reporting of this aspect was incorporated into a more general examination of the consequences of problems of water quality, quantity, and availability.

COST

The NSA assessed the cost of rural water from the perspective of both rural households and supply systems. Costs to rural households were measured from information on water bills, when available; this approach was reliable, but limited to those households served by systems which billed for the water used. Costs to households with individual water supplies were not assessed directly in the NSA, since household records of the various possible costs were expected to be incomplete. The cost of installing individual supplies—drilling a well, for instance—often is hidden in the purchase price of a house, and maintenance expenses occur irregularly. However, the NSA also ascertained people's perceptions about the cost of the household water supply, and these perceptions were compared for all households. From the perspective of water supply systems which served rural households, the NSA assessed systems' expenses for debt retirement and for operation and maintenance, and also examined systems' financing arrangements.

AFFORDABILITY

In addition to measuring cost as such, the NSA assessed the cost of water relative to rural households' ability to pay for it. Specifically, affordability was represented by a ratio of the cost to the total household income. Because household cost data were limited to households served by multiple-connection supply systems, the affordability of water to households on individual supplies could not be addressed directly. However, the NSA asked residents of all rural households to judge the value of the water in relation to its cost in time, labor, or capital, as residents perceived these costs, and these data facilitated useful comparisons.

STRUCTURE OF NSA SURVEY

An extended discussion of the methodology used in the NSA investigation is presented in Appendices B and C of this report. Three topics of major importance to understanding the validity and scientific merit of the investigation are summarized here. First, a condensation of the sampling procedure is presented. Second is a short description of the manner in which the data was collected, as well as the range of subject matters covered in the investigation. Third is an overview of the way in which research results were treated and presented in the descriptive portion of the report (Chapters III through VIII) and in the analytic portions (Chapters IX through XIII).

SELECTION OF RURAL HOUSEHOLDS

Households were selected for study in the NSA as a result of a complex sampling procedure which ensured that they would be representative of rural households across the US and in several subnational groupings. Details of the sampling design are presented in Appendix B, along with data from the 1970 US Census and the 1976 Annual Housing Survey which illustrate the close comparability between NSA households and rural households as described in the census. (The NSA defined rural households as the 1970 census did: households in communities of fewer than 2,500 people, and households in other rural areas.) A brief summary of the sample design is presented here.

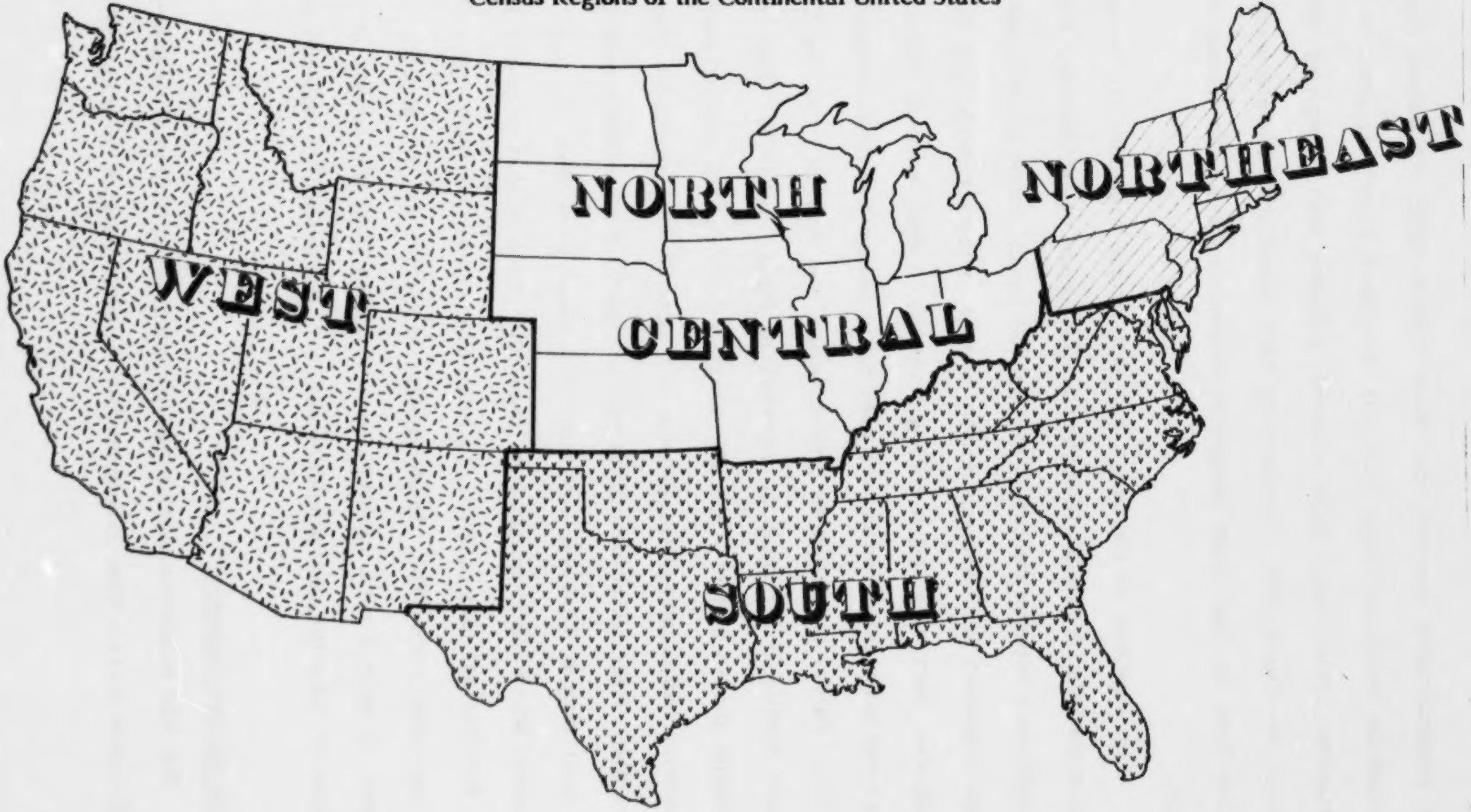
Since the NSA was limited to domestic water conditions in rural areas of the US, only rural households were eligible for selection. The relatively modest size of the sample (2,654 households) made representative sampling especially important. The selection was done in four stages, beginning with a review of basic rural population data provided by the US Bureau of the Census and ending with final choices made by interviewers in the field.

In the first stage, sampling experts studied 1970 rural population and housing data, supplemented by data from the 1976 Annual Housing Survey, for all counties in the continental US (the 48 contiguous states), and adjusted the 1970 data to reflect estimated rural population and housing patterns in 1978. The counties (numbering about 3,000) were grouped into four standard census regions (see Figure II-1), and 400 counties were randomly selected. In the second stage, 2,779 census enumeration districts were chosen within the 400 selected counties. In the third stage, small sampling areas within the districts, called "chunks," or areal segments, were chosen. An average of one chunk per enumeration district was used for data collection purposes. In the fourth stage, all dwelling units in each chunk (which were counted as households if they were regularly occupied) were listed. Then an average of 1.2 households in each chunk was randomly selected directly or via a subsampling process. The step-by-step selection process ultimately led to interviews in 2,654 households. These 2,654 households represented an estimated 22 million rural dwelling units in the continental US as of late summer, 1978.

All four stages of selection involved the use of a systematic probability sampling design based on selecting each unit with probability proportionate to size. Built into the selection process were checks and safeguards to insure representative selection (see Appendix B). The result was that households were proportionately selected from places with populations of 1,000 to 2,500, places with populations of less than 1,000, and other rural areas. Moreover, rural households

Figure II-1

Census Regions of the Continental United States


NORTH
CENTRAL
NORTHEAST
WEST
SOUTH

adapted from Bureau of the Census information were proportionately selected from those located inside and outside Standard Metropolitan Statistical Areas (officially designated geographic areas in which metropolitan centers exert major economic influence even in outlying nonurban sections, see Figure II-2). Furthermore, rural households were proportionately selected from the four broad geographic regions in use by the Bureau of the Census.

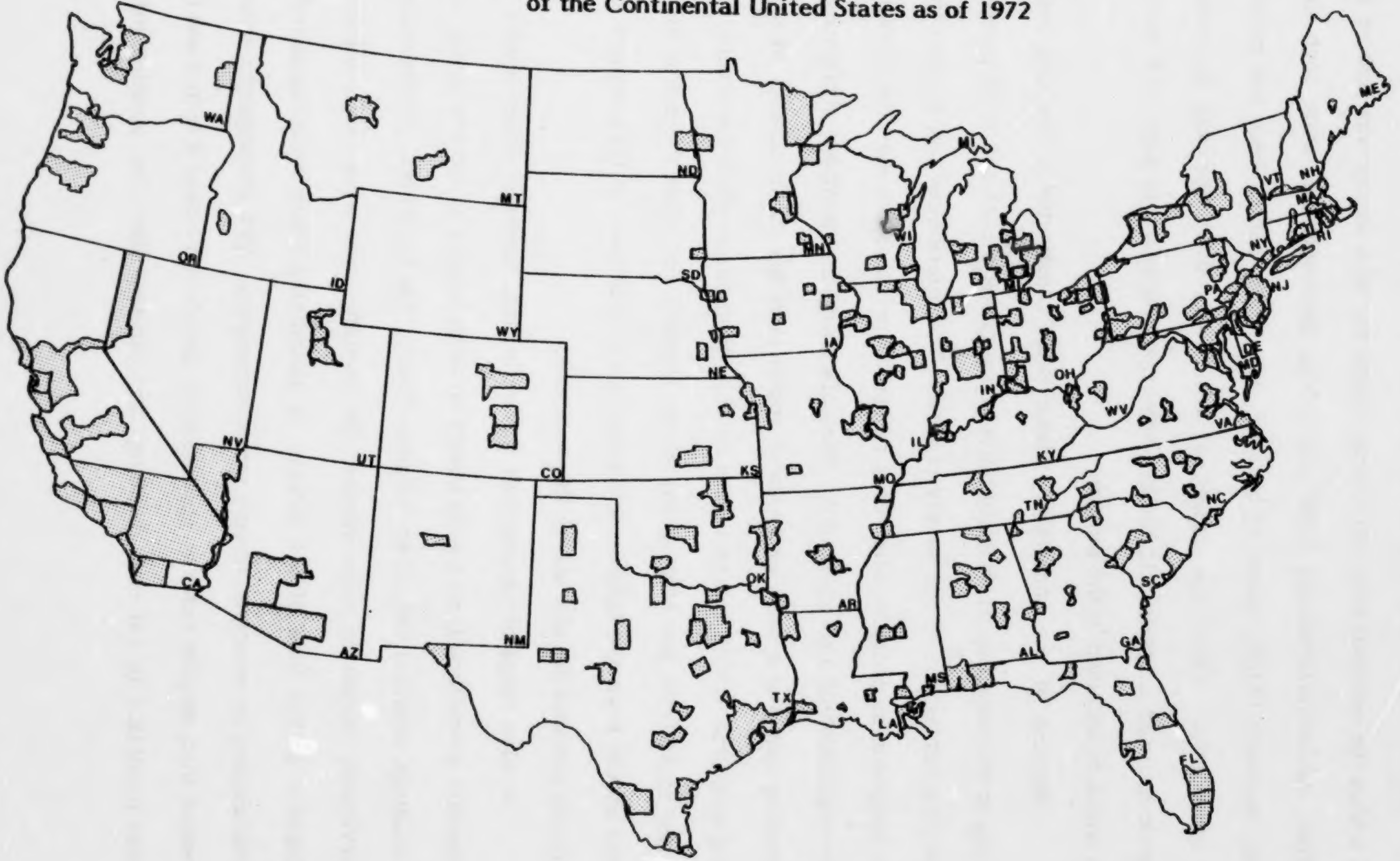
One drawback of the design was that sample selection was necessarily based on the 1970 US Census of Population. This caused two difficulties. First, in the eight years between the census and the NSA survey, formerly rural areas had become urbanized, but there was no sure method to correct the sample for this development short of taking a housing inventory in each selected enumeration district—an option which would have been too expensive and time-consuming for the NSA. Partial correction for this difficulty was attained using the Census Bureau's Population Estimates of Incorporated Places for 1975. That census information showed that 25 of the approximately 2,800 initially selected enumeration districts had become urban districts, and these 25 were eliminated from the NSA sample. These corrective efforts were only partially successful in producing a pure rural sample, however, and some interviews were done in areas with populations which had increased from fewer than 2,500 in 1970 to over 2,500 in 1978. A second difficulty occurred as a result of the general increase in size of the rural population since 1970. In an attempt to correct for this growth, it was necessary to apply a ratio weighting process before using the sample to make estimates for the entire rural population as of 1978 (for details, see Appendix B).

Defining the rural household

The NSA studied households that fell within the definition of rural used by the US Census Bureau: those in incorporated or unincorporated communities with

Figure II-2

Standard Metropolitan Statistical Areas (SMSAs)
of the Continental United States as of 1972



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adapted from Bureau of the Census information populations of less than 2,500, and those in other rural areas not designated as places.

In the fourth stage of NSA sampling, the interviewer listed every dwelling unit within the selected sampling chunk. Since the NSA survey was limited to the civilian, noninstitutionalized rural population, nonresidential units such as hospitals, transient hotels, places of business, and resort cabins were not considered for interviews. Once the listing of residential dwellings was finished, the interviewer used a systematic random-selection procedure to pick each household that would be included in the sample.

Because of the uncertainty about what constituted a dwelling unit, the listing, or enumerating, of dwelling units in the chunk turned out to be perhaps the most difficult aspect of the survey process. The interviewer had to use considerable judgment in deciding whether a residence or structure met the census—and NSA—definition of a dwelling unit. The definition was essentially straightforward: a dwelling unit was a room or group of rooms intended for occupancy as separate living quarters. Living quarters were considered separate when the occupants lived and ate apart from any other group in the building and when there was either (1) direct access from the outside or through a common hall, or (2) complete kitchen facilities intended for sole use by the occupants.

A wide range of housing met this definition, however. Interviewers had to enumerate everything from family homes on large estates to remote living quarters in buildings intended for other purposes (barns, for example). Furthermore, the interviewers needed to judge whether the dwelling units were really intended for occupancy at the time of the survey. A dilapidated house which appeared to be uninhabitable, for example, usually would not qualify. Yet investigation sometimes revealed that, despite exterior appearances, people did indeed live in these houses. It was important to list such dwellings and consider them for possible interview visits since, among other things, household water conditions clearly could be closely linked to the physical integrity of the structures.

For the purposes of the NSA, then, a structure was considered a dwelling unit if it was intended for human occupancy and if it met the other criteria stipulated above. A household was defined as an occupied dwelling unit, and all persons occupying the dwelling unit on a regular basis were considered members of the household.

The interviewers were given detailed instructions to guide their decisions, and they were in frequent contact with the survey research organization which supervised their activities. In addition, they were given special training to prepare them for the survey responsibilities, and a subset of their fieldwork was reexamined by roving field supervisors to ensure the validity of results. These procedures were implemented to minimize error, and are detailed in Appendix C.

Results of Sampling Design

The elaborate sampling scheme resulted in a selection of rural households as depicted in Table II-1. The first column contains NSA estimations of the number of rural households represented in each cell of the sampling frame—in other words, the estimates which resulted from applying ratio sampling weights to the sample. The second column, the "unweighted sample," gives the actual number of households where data were collected for each cell of the full NSA sample (2,654 households in all). The third column of Table II-1 gives the actual number of households in each cell where additional water quality data were collected (a subsample of 267 households).

It is important to note that in each of the three columns, the percentage of households in each cell is approximately the same. The largest discrepancy between the weighted sample and the unweighted full NSA sample—6.0 percent—occurred for households served by community water supply systems, while the

Table II-1
Distribution of NSA Sample

	Number and Percent of Households		
Grouping	Estimated Number of Households (Weighted Sample)	Unweighted Sample	Unweighted Subsample
Region			
Northeast	3,693,000 16.8%	527 19.9%	47 17.6%
North Central	6,213,000 28.3%	726 27.4%	67 25.1%
South	9,291,000 42.3%	1,087 41.0%	121 45.3%
West	2,777,000 12.6%	314 11.8%	32 12.0%
Total	21,974,000 100.0%	2,654 100.1%	267 100.0%
SMSA/NonSMSA			
SMSA	7,040,000 32.0%	790 29.8%	72 27.0%
NonSMSA	14,934,000 68.0%	1,864 70.2%	195 73.0%
Total	21,974,000 100.0%	2,654 100.0%	267 100.0%

Table II-1 continued

	Number and Percent of Households		
Grouping	Estimated Number of Households (Weighted Sample)	Unweighted Sample	Unweighted Subsample
Size of Place			
Large rural communities	2,369,000	254	21
	10.8%	9.6%	7.9%
Small rural communities	1,509,000	208	21
	6.9%	7.8%	7.9%
Other rural areas	18,095,000	2,192	225
	82.3%	82.6%	84.3
Total	21,974,000	2,654	267
	100.0%	100.0%	100.1%
Size of System			
Individual	8,765,000	1,193	115
	39.9%	45.0%	43.1%
Intermediate	2,228,000	294	30
	10.1%	11.1%	11.2%
Community	10,981,000	1,167	122
	50.0%	44.0%	45.7%
Total	21,974,000	2,654	267
	100.0%	100.1%	100.0%

average discrepancy was 2.1 percent. As one might expect, discrepancies between the household estimates and the unweighted subsample (third column) were somewhat larger. The average discrepancy between the weighted and the unweighted subsample was 2.7 percent, with the largest discrepancy appearing in the SMSA/nonSMSA grouping. The correspondence between weighted and unweighted proportions—a feature of any well-constructed sample—means that, in general, conclusions would be approximately the same whether they were based on weighted or unweighted data.

Reflecting the uneven distribution of rural households in the US, the South had the greatest number of sampled households in the regional distribution. Similarly, the sample included more than twice as many nonSMSA households as SMSA households, and most of the selected households were located in other rural areas rather than in large or small rural communities. There were about equal numbers of households selected which were served by individual and by community water supply systems, while the sample included a relatively small number of households which were served by intermediate systems. Appendix B contains comparisons between the weighted NSA sample and the 1970 Census and 1976 Annual Housing Survey.

DATA COLLECTION

At each household in the NSA sample, the resident most knowledgeable about the water supply was selected to be interviewed—usually, the head or co-head of the household. Direct questioning generally took between 40 and 50 minutes. During the interviews, perceptions of the water's odor, taste, temperature, clarity, color, sediment content, quantity, and pressure were explored. For each of these characteristics, the household respondent was asked to report the presence of the characteristic, a description of it, the frequency of its occurrence, possible reasons for its presence, changes in the characteristic, seasonal variations, and the respondent's feelings about the characteristic. Household respondents also reported any incidents of illness that they attributed to the household water, and incidents of any miscellaneous problems. In addition, they assessed the cost of the water and supplied objective information about the cost when water bills were available.

Household interviews also identified the household water uses, the physical characteristics of the water supply and wastewater systems, breakdowns in either system, and demographic characteristics of all residents of the household. Further, the household representative was questioned about secondary water supplies used at the household, including reasons for having supplementary supplies.

Subjective preferences and perceptions about water received a great deal of attention in the NSA not only because feelings about aesthetic qualities of water have to be considered by policy makers, but because people's subjective evaluations of household water may greatly affect their water usage. Another reason for recording information on·perceptions was to supplement laboratory water quality data by providing a comparison point.

Some questions were aimed at the history of individual systems. In households served by individual wells, for instance, respondents were asked the age of the well or well modifications, whether a permit or approval was required by any government agency when the well was installed or substantially altered, the method used in constructing the well, the depth and size of the well, and whether the well was grouted. Household representatives also were asked if they thought the household water supply had been subject to contamination from any source during the year prior to the NSA, and the results of any past water quality tests performed on the household water, along with the reasons for such tests.

In addition, NSA interviewers, who had undergone two weeks of special training, personally inspected the household water supply and noted its apparatus, treatment facilities, state of repair, and any possible sources of contamination.

The interviewers measured the temperature and water pressure from a household tap, and measured the capacity of any pressure tanks and water pumps that were present. Interviewers also collected a set of several specimens of water drawn from a household tap, and sent the specimens to various laboratories for assay of bacterial content, chemical constituents, and physical characteristics (color, turbidity, and specific conductance). In addition, water specimens from 10 percent of the households were examined for herbicides, heavy metals, pesticides, and radioactivity.

For every household served by a community or intermediate supply system, a separate interview was conducted with a knowledgeable manager or employee of the system. These interviews gathered information about the system's size, age, facilities, number of employees, financing, regulation, and program of water quality testing. Also brought out were any problems in acquiring water from the system's sources, and the system's history of breakdowns.

PRESENTATION OF RESULTS: DESCRIPTIVE CHAPTERS

In this report, estimates of rural water conditions are presented first on a national basis. The sample size of the NSA allowed national estimates to portray overall conditions very accurately. However, because national estimates could obscure important variations that might occur in different parts of the US, the NSA also made various subnational groupings of its findings. These subnational results should be interpreted with greater caution because of the smaller numbers of households taken into account. Nonetheless, these comparisons portray important variations that add significantly to an understanding of causative factors in rural water conditions. Four kinds of subnational groupings were made routinely in the NSA. They are described below.

Regional. Regional variations in rural water conditions and supply systems are presented for comparison with national estimates and to show the range of conditions more accurately. Regional data reflect broadbase differences that may be caused by variations in climate, geology, population distribution, economic base, or other characteristics. (The NSA used the four major regional divisions used by the US Census Bureau; see Figure II-1.)

SMSA/NonSMSA. Significant differences also were anticipated between households and supply systems that were located within Standard Metropolitan Statistical Areas (SMSAs) and those that were located outside of SMSAs. In general, households located within SMSAs have greater accessibility to a wide range of services, since they are closer to and likely to be under the economic influence of nearby urban centers. It was anticipated that SMSA households and nonSMSA households might show the same pattern of variation with regard to water supply as they commonly do with regard to other services. (Figure II-2 is a map showing the areas within the continental United States that were designated as SMSAs as of 1972.)

Size-of-Place. The NSA also compared water conditions according to the size of the population where households and supply systems were located. These comparisons were based in part on a hypothesis that population size and density largely determine the types of water supplies that are in use. Specifically, it was thought that the larger and more concentrated the population base, the more likely that households would be served by community systems.

For the size-of-place comparison, households were divided into three classifications according to whether they were located in large rural communities (places where the population was 1,000 through 2,499); small rural communities (places where the population was 999 or less); or other rural areas.

Size-of-System. Also potentially important for understanding the dynamics of rural water supply was a breakdown of household data by the size of the supply system serving the household. Several factors made this breakdown useful for the NSA data analysis. Obviously, individual supply systems are based on much simpler physical configurations than are community systems, and are subject to far less regulation. However, multiple-connection systems of various sizes also show great variation in their physical configurations, have different problems, have different levels of complexity in their distribution systems, and are subject to different economic forces. Considerations such as these meant that examining household data according to size of system might be useful in explaining differences in household water conditions.

As explained earlier in this chapter, households were divided into three groups for this comparison: those served by individual systems (one household); those served by intermediate systems (two through fourteen connections); and those served by community systems (fifteen or more connections).

Estimates of household water conditions for smaller segments of the US—at the state level, for instance—were not attempted because the small number of rural households in such segments would not allow reliable estimation.

Other possible groupings for presentation of data

The four groupings selected for presentation of subnational variations in rural water conditions and supply systems constitute only one of many possible schemes which could have been used for this purpose. There were several factors which dictated the use of these groupings. A major factor in the decision was that the dimensions of region, SMSA/nonSMSA, and size of place were an integral part of the sampling frame used in the selection of households, and that these dimensions thus constituted a constraint on the information that was collected. Second, aggregating households and systems according to these broad groupings generally resulted in enough cases being in each group to permit meaningful statistical comparisons. The third factor involved in the decision was the judgment that these groupings would correspond to the major sources of variation in the data, though they might not be optimal groupings for any one variable or subset of variables.

Other analytical distinctions which might be useful theoretically or particularly relevant to programs were introduced as factors for consideration in the model construction and data analysis. Ethnic and racial differences, for example, have been postulated as being important considerations in the quality, quantity, and cost of water in rural America. Certainly this finding would have implications for various minority programs. Income differences represent another factor which might be an important determinant of variation in the status of water supplies. If true, such a finding would have programmatic implications for poverty research and funding. Presenting information on household drinking water conditions for various geologic regions or water resource regions also was suggested. Still another suggested scheme was to compare the NSA information with measures of source water quality which could be obtained from the United States Geologic Service sampling program.

The specific manner in which these options were handled in the NSA was to restrict the descriptive material (Chapters III through VIII) to national estimates and subnational groupings based on region, SMSA/nonSMSA, size of place, and size of system. Additional factors were investigated as part of the data analysis, which involved the search for the most relevant set of factors associated with variations in quality, quantity, availability, and cost of water. That is, data analysis first tested simple associations—between ethnicity and household water quality, for example, or between income and water usage. Second, in the multivariate model construction, these factors were introduced as independent variables in addition to the stratifiers of region, SMSA/nonSMSA, size of place, and size of system which were included in every model.

PRESENTATION OF RESULTS: ANALYTICAL CHAPTERS

The orientation and treatment of results differed substantially between the descriptive chapters (III through VIII) and the analytical chapters (IX through XIII). For one thing, no subnational results in the sense of region, SMSA, size of place, or size of system are presented in the analytical chapters. Whereas the purpose of the descriptive chapters is to present in a straightforward manner the univariate results with little interpretation or concern with how one variable relates to another, the opposite purpose holds for the analytic chapters which emphasize the relations between variables leading to various conclusions and interpretations not possible in the descriptive chapters.

STRUCTURE OF REPORT

Chapter I of the report consisted of a technical summary of all NSA findings. Detailed descriptive findings begin in Chapter III, which presents a demographic profile of rural households and further describes them in terms of water use and general attitudes toward their water supplies. Chapter IV tabulates the number of rural households using various kinds of water supplies. Chapter V examines rural water supplies in terms of quality, quantity, availability, cost, and affordability. It includes both objective and subjective (perceptual) measures of these components of domestic water supply. Chapter VI provides composite measures which facilitate a more general evaluation of household water conditions.

Chapter VII changes the focus of the report to water supply systems, and examines systems both in terms of physical components and social and organizational aspects. Chapter VIII describes water supply systems from an economic viewpoint, and concludes the descriptive findings of the NSA.

The concluding chapters of the report explore relationships among the various descriptive findings in order to identify the characteristics and forces which seem to have an impact on various aspects of rural water conditions.

The interview schedule used in the NSA is included as Appendix A of this report. Appendix B details the survey design and sampling methodology; it also includes a table of estimated sampling errors for various kinds of NSA data. Appendix C is an expanded quality assurance report. It sets forth the mechanisms used in the NSA to ensure data of high quality for the survey as a whole: the survey instrumentation and pretesting, the training of interviewers and coders, the monitoring of the data collection, and the techniques used for detecting and resolving coding and keypunching errors. With specific regard to NSA water quality testing, Appendix C provides laboratory quality assurance data.

This voluminous report brings together many disparate factors related to rural household water conditions. Its detailed description and analysis of those factors provide the comprehensive body of information needed for addressing the vital issues of rural water supply that are anticipated in the 1980s.

REFERENCES

[1] Separate studies included the following:

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US Environmental Protection Agency, Region X. *Idaho Water Supply Program Evaluation: Summary.* Seattle, Washington: US Environmental Protection Agency, October 1973.

US Environmental Protection Agency, Region I. *Evaluation of the Connecticut Water Supply Program.* US Environmental Protection Agency, September 1974.

[2] McCabe et al.

[3] McCabe et al.

III

Characteristics of Rural Water Users and Households

The main thrust of the NSA and of this report is, of course, to investigate the myriad aspects of household water conditions in rural America. As a reference document, the report deals with these issues in great detail. It addresses the physical aspects of water supply, household water quality, the amount of water available to rural households, the cost of water, and the financing and regulation of water supply. An appreciation of the findings, however, rests on a knowledge of the people whose water conditions are being discussed. The purpose of this chapter is to define and describe the people whose water conditions were studied in the NSA, and to delineate some of the differences that existed among them. Some of these differences emerged in a comparison of rural households across the four broad census regions of the country; others could be seen in the comparison of households located within and outside of SMSAs; still others were seen when households were compared according to the size of the place where they were located and according to the size of the water supply system serving them.

The underlying purpose of this chapter is to establish the social context within which NSA findings can be evaluated. Accordingly, the chapter depicts socioeconomic aspects of rural households, identifies household patterns of water use, profiles the nature and extent of plumbing and water-using fixtures present in rural households, and explores residents' general orientation toward their water supplies.

In this report, rural households are described by a number of selected attributes relating both to the housing structures and to the household residents. These demographic attributes contribute to an understanding of the social context of national, regional, and other variations in water conditions. They are integral also to the NSA analysis of the reasons for those conditions.

The demographic information addresses questions like: What is the typical size of rural households? How many are located in small rural communities or villages, in larger communities, and in other rural areas? How many are on the "fringe" of large cities—that is, in SMSAs? How long have residents lived in their present homes and been served by the same water supply? How many own their homes? What is the employment picture for heads of rural households and what are the income patterns? These factors were examined in order to establish the range of differences among rural households, and will be explored later for correspondences with differences in various aspects of rural water supply.

Following the demographic information, household water use is explored, and a statistical profile is compiled of the water-using appliances and fixtures present in rural households. Regardless of how a household obtained its water supply, the household was considered the terminal point for use of the supply. Consequently, the household and its surrounding structure were the focus of investigation regarding both indoor water use and distribution for outdoor use, as well as disposal of wastewater. Thus, in addition to compiling information about household residents, the NSA surveyed the uses of water in each household. At issue is the extent to which rural households restricted use of their major household water supply to the basic functions of drinking, cooking, bathing, flushing, washing dishes, and washing clothes. How many households also used the supply to water lawns, to water livestock, to irrigate crops, to cool the house, or to fill swimming pools? By contrast, how many households did not use the major supply for drinking or for other basic uses?

Information about the kinds of water-using appliances present in a household, and the number of these items, was directly related, of course, to how the household used its water supply. In addition, such information provided contextual data essential to understanding the sufficiency and limitations of various types of water supplies for rural households. To state one obvious example, in order to accommodate an automatic washing machine or dishwasher, a supply must be capable of delivering more water under higher pressure than would be necessary for a household which did not have or use those devices.

The respondents also were asked to report the type of wastewater disposal system at the household, which would receive the collective output of the water-using devices. For example, did wastewater go untreated to a natural body of water, or to a septic tank, cesspool, or other disposal system? Furthermore, since the reliability of the disposal systems could be expected to influence water use, or even water quality, respondents were asked whether there had been breakdowns in the systems, and the nature and seriousness of the breakdowns.

To fill out the contextual information on rural households, each respondent's attitudes toward the water supply also were explored. A series of questions sought to identify the respondent's satisfaction with his present supply, preferences for different types of supplies, reasons for the preferences, specific features of the existing supply which were liked and disliked, and general problems with the existing supply. Respondents also were asked to compare the existing system with an idealized one.

In short, because the rural household was the focal point for the collection of data and the basic analytical unit for most NSA analyses, it is important to begin the NSA report by portraying rural households' socioeconomic profiles, their patterns of water consumption, and their overall attitudes toward their water supplies. This information will serve as a framework for understanding the significance of many NSA results. As indicated in Chapter II, the information is presented for the nation and for various comparative subnational groupings so that it can be compared with findings about rural water conditions given in later chapters.

Here, sociodemographic attributes are presented first. Together, they comprise a social profile of rural households and the context in which water supplies are sought and used in rural areas of the US.

DEMOGRAPHIC PROFILE OF RURAL US

The following profile of rural America is made up of two sets of demographic attributes, those that describe households and those that pertain to heads of households. First, rural households are described in terms of their structural type and the number of dwelling units in the structures (whether they were single-family or multiple-family units, and whether they were conventional housing structures or mobile homes). Other data include ownership (housing tenure), the number of people in the household, household income, and the length of time that residents had lived in the household at the time of the NSA. Heads of rural households are described by their sex, ethnicity, age, education, employment status, and occupation.

First, the national demographic profile of rural households is presented in its entirety. Subsequent sections treat differences among the four major regions of the US, differences between SMSA and nonSMSA households, and differences among households located in large rural communities, small rural communities, and other rural areas.

To provide perspective, frequent comparisons are made throughout the chapter between NSA results and 1970 census data. When appropriate, note is made of salient trends which have developed since 1970. A detailed comparison between census and NSA findings is presented in Appendix B, as is a detailed explanation of the statistical procedures used in generating the NSA sample.

ATTRIBUTES OF RURAL HOUSEHOLDS

Number of occupied rural housing units

About 31 percent of Americans lived in rural areas of the United States in 1978, according to estimates derived from the 1976 and 1977 Annual Housing Surveys. In terms of households, it was estimated from NSA data that at the survey's midpoint (September 1978), there were about 21,974,000 occupied housing units in rural areas. (In keeping with the Bureau of the Census definition, rural households were defined as those in places with populations of less than 2,500 and those in other rural areas.) Household projections were based on the 1970 Census of Housing and on estimates of occupied rural housing units obtained in the Annual Housing Survey for the years 1974, 1975, 1976, and 1977.

Number of farm and nonfarm occupied units

Of the estimated 21,974,000 occupied rural housing units in the US, about 3.7 million households (16.9 percent) either owned or leased a farm, and about 18.3 million (83.1 percent) did not. Of the 3.7 million households that did own or lease a farm, 960,000 had no income from the sale of farm products. Excluding these 960,000 households—consistent with the definition of farm units used by both the United States Department of Agriculture (USDA) and the Census Bureau—the resultant NSA estimate of the number of farm units (2.6 million) was in close agreement with census data. The Census of Agriculture estimated that there were 2.7 million farm units in 1969 and 2.3 million in 1974. In 1978, USDA also estimated that there were 2.7 million farms in the US.[1]

Number of units in structure

Rural housing commonly is thought to consist of single-family dwelling units. This was confirmed by the NSA, as it was by the 1970 Census of Housing and the Annual Housing Surveys. It was estimated that about 17.9 million (81.4 percent) of the occupied rural housing units in late 1978 consisted of single-family conventional housing. Another 2.7 million units (12.3 percent) were single-family mobile homes. In total, 20.6 million units, or 93.7 percent of all rural housing units, were single-family units.

In contrast, about 515,000 units (2.3 percent) were located in structures containing two to four units, and about 869,000 (4.0 percent) were located in larger buildings such as apartments containing five or more households. Determination of the household's location in single- versus multiple-unit housing structures aided in detecting possible household differences in quantity and availability of water, as well as in the type of water supplies.

The NSA estimate of the number of mobile homes in rural areas indicates the continuation of a trend since 1970 toward more of that type of housing (see Appendix B for details).

Number of persons in household

The number of people in the household clearly had a bearing on the amount and type of water consumption. Accordingly, a concerted effort was made to determine the exact number of people in each household. As seen in Table III-1, almost half of the households consisted of one or two persons. On the basis of NSA results, the estimated national median number of occupants of rural dwelling units was 2.6, which indicated a continuing trend toward declining household size in rural areas. (The median size reported in the 1976 Annual Housing Survey was 2.7, while the median in the 1970 census was 2.9.)

Table III-1

Number of Persons in Rural Households

Number of Persons in Household	Nation	
	Number of Households	Percent of Households
1 person	2,954,000	13.4
2 persons	7,415,000	33.7
3 persons	4,143,000	18.9
4 persons	3,873,000	17.6
5 persons	1,917,000	8.7
6 persons	1,010,000	4.6
7 or more	661,000	3.0
Total	21,974,000	99.9

Each figure in the table is rounded independently; numbers and percentages may not equal rounded totals.

Housing tenure (ownership arrangements)

Based on the NSA sample, it was estimated that about 17.4 million rural households (79.4 percent) were owner-occupied, and 3.9 million (17.8 percent) were renter-occupied. The remaining households (607,000, or 2.8 percent) were occupied by people who had other tenure arrangements.

Household income

Rural Americans may derive income from both farming and nonfarming occupations, but because it is difficult to compare income from the two sources, farm income and nonfarm income were tabulated separately. Nonfarm income consisted of income from all sources other than farm sales, including wages and salaries, interest and dividend income, pensions, and net business profits (for those who were self-employed in businesses other than farming). It did not include any income from farm sales or net farm income.

For all households, whether or not they showed farm income, the NSA tabulated the total nonfarm income of everyone in the household, combined. For those households that also owned or leased a farm, gross farm income (sales) and net farm income were tabulated. A special effort was made to keep nonfarm income distinct from farm income. If the head of the household owned or leased a farm, separate questions were used to determine the amount of income derived from nonfarm occupations and the amount derived from farming. For farm laborers who did not own or lease a farm, income was simply considered as wages and tabulated as nonfarm income.

To maintain the necessary distinctions between sources of income, data are tabulated and presented below separately for nonfarm income, gross farm income (income from farm sales), and net farm income (income from farm sales after deductions, expenses, and taxes). Then, to make the income data comparable with statistics reported by the Bureau of the Census for households involved in farming, net farm income was merged with income from nonfarm sources to estimate the total household income. This new distribution, which was tabulated to reflect income from all sources, is presented after the data on income from the other sources discussed above.

Nonfarm income

Over half a million rural households derived no income from nonfarm sources. Generally, their income came exclusively from farm sources.

Approximately one-fourth of all rural households had combined income from all nonfarm sources of less than $8,000. At the other extreme, less than one-fifth (18.8 percent) had income from all nonfarm sources of $25,000 or more. The median household income from nonfarm sources was $12,676. Table III-2 shows income from all nonfarm sources among occupied rural households in late 1978.

Gross farm income (farm sales)

As indicated in Table III-3, 508,000 rural households (19.5 percent of the estimated 2.6 million households with farm income) reported gross sales between $1 and $2,500. Another 224,000 households (8.6 percent) reported sales between $2,500 and $4,999. Hence, over one-fourth of the households with farm income reported sales of less than $5,000. By contrast, over one-fifth reported sales of $20,000 or more. Unfortunately, 29.2 percent of the 2.6 million households with farm income did not report their income from sale of products, making it difficult to render an accurate assessment of the relative distribution of gross farm income.

Net farm income

Net farm income data are very difficult to interpret, since researchers are not in agreement as to what the information really signifies as an indicator of disposable income for farm families or as an indicator of potential life style. For

Table III-2
Household Income Derived from Nonfarm Sources

Income	Nation Number of Households	 Percent of Households
No nonfarm income	515,000	2.3
$1-2,999	1,114,000	5.1
$3,000 - 3,999	973,000	4.4
$4,000 - 4,999	560,000	2.5
$5,000 - 5,999	665,000	3.0
$6,000 - 6,999	815,000	3.7
$7,000 - 7,999	741,000	3.4
$8,000 - 9,999	1,338,000	6.1
$10,000 - 12,499	2,969,000	13.5
$12,500 - 14,999	1,312,000	6.0
$15,000 - 19,999	2,917,000	13.3
$20,000 - 24,999	2,257,000	10.3
$25,000 - 34,999	2,302,000	10.5
$35,000 or more	1,829,000	8.3
Unknown	1,666,000	7.6
Total	21,974,000	100.0

Each figure in the table is rounded independently; numbers and percentages may not equal rounded totals.

Table III-3
Gross Farm Income (Farm Sales)

Income/Sales	Nation Number of Households	 Percent of Households
$1 - $2,499	508,000	19.5
$2,500-4,999	224,000	8.6
$5,000-9,999	305,000	11.7
$10,000-19,999	247,000	9.5
$20,000-39,999	191,000	7.3
$40,000-99,999	231,000	8.9
$100,000 or more	135,000	5.2
Unknown	759,000	29.2
*Total	2,600,000	99.9

*Table excludes households which had no income from the sale of farm products.

Each figure in the table is rounded independently; numbers and percentages may not equal rounded totals.

one thing, people having the largest farms and the most wealth in terms of total assets often can report negative net incomes. There are several reasons for this; regardless of farm size, for example, mechanization requires a heavy capital investment, reducing farm households' disposable income. Other possible reasons for a negative net income might be the loss of a cash crop in a given year, and the inability to depreciate capital costs. These economic forces apparently influenced NSA results, as they have other studies.

Net incomes of less than one dollar (including negative incomes) were reported for 350,000 households (13.4 percent). An additional 528,000 households (20.3 percent) reported net farm income between $1 and $2,499. Hence, about one-third of those farms having some farm income reported a net income below $2,500. By contrast, 8.0 percent had a net income from farm operations of $20,000 or more. Table III-4 presents the details. Unfortunately, as with other income data, a large proportion (27.6 percent) did not provide the requested information, and the effect of this on the distribution presented in Table III-4 is not known.

Total household income

The tabulation of total household income combines information on households having only nonfarm income with information on both farm and nonfarm income for households that owned or leased a farm. That is, for households involved in farming, total household income was determined by adding net farm income to all nonfarm income. Net farm income was included even if it was negative and therefore decreased total household income. This procedure is followed by the Bureau of the Census and other data collection agencies.

About 188,000 households (7.2 percent of the 2.6 million households from which farm income data were obtained) reported negative net farm income, while approximately 162,000 households (6.2 percent of those involved) reported a net farm income of zero. The remaining households (86.6 percent) had positive net

Table III-4

Net Farm Income

Income	Nation Number of Households	Percent of Households
Less than $1	350,000	13.4
$1 - 2,499	528,000	20.3
$2,500 - 4,999	176,000	6.8
$5,000 - 9,999	351,000	13.5
$10,000 - 19,999	272,000	10.5
$20,000 - 39,999	132,000	5.1
$40,000 - 99,999	48,000	1.9
$100,000 or more	25,000	1.0
Unknown	717,000	27.6
*Total	2,599,000	100.1

*Table excludes households which had no income from the sale of farm products.

Each figure in the table is rounded independently; numbers and percentages may not equal rounded totals.

farm incomes. Given the small proportion of households reporting negative farm income, one would expect the combined amount, the total household income, to show slightly larger proportions of households in the higher and middle-income brackets.

Table III-5 displays total household income from all sources. It shows the same distributional pattern as nonfarm income (which was presented in Table III-2). In fact, the only notable differences are an increase of two percentage points in the unknown category and the expected, though very small, shift towards higher income brackets.

Median income was somewhat lower for rural households than for US households in general. Total household income among rural households in the year preceding the NSA showed a median of $12,818, compared to a 1978 median for all US households of $13,512 (US median based on 1978 Annual Housing Survey figures).

Length of residence

The length of time that the household occupants had lived in their present homes obviously had a bearing on the amount of experience they had with their water supplies. Longer periods of residence imply that the occupants have had more time to accumulate knowledge of the water supply's usual condition and to notice changes in its characteristics. In addition, it was anticipated that the length of residence might influence the extent of occupants' willingness to maintain or improve a water supply, as well as the extent of their adjustment to the supply.

Based on the NSA sample, it was estimated that approximately 5.2 million rural households (23.4 percent) had been occupied by the present residents one year or less. (NSA data on length of residence really reflected the years since the head of the household moved into the unit.) Residents of an additional 6.1

Table III-5

Total Household Income

Income	Nation	
	Number of Households	Percent of Households
Less than $3,000	1,193,000	5.4
$3,000 - 3,999	890,000	4.1
$4,000 - 4,999	546,000	2.5
$5,000 - 5,999	622,000	2.8
$6,000 - 6,999	775,000	3.5
$7,000 - 7,999	748,000	3.4
$8,000 - 9,999	1,305,000	5.9
$10,000 - 12,499	3,010,000	13.7
$12,500 - 14,999	1,313,000	6.0
$15,000 - 19,999	2,984,000	13.6
$20,000 - 24,999	2,216,000	10.1
$25,000 - 34,999	2,305,000	10.5
$35,000 or more	1,952,000	8.9
Unknown	2,114,000	9.6
Total	21,974,000	100.0

Each figure in the table is rounded independently; numbers and percentages may not equal rounded totals.

million households (27.7 percent) had lived at the present unit between two and five years, and the residents of about 3.5 million households (16.1 percent) had lived there between six and ten years. These three categories accounted for 67.2 percent of all households in rural America in late 1978. By contrast, residents of about 3.9 million households (17.7 percent) had lived in the present unit for more than twenty years. Detailed results are presented in Table III-6. The median length of residence among rural households was roughly five years and three months.

ATTRIBUTES OF HOUSEHOLD HEADS

The demographic factors presented so far have been related to the dwelling unit itself or have represented a collective attribute of its occupants, such as total combined income. Other demographic characteristics—such as age, sex, ethnicity, and education—relate to individual members of a household; nonetheless, they are often used as critical descriptive characteristics of households. This section describes these characteristics for the heads of rural households. (Social scientists describing households rather than individuals usually report individual demographic features only for the head of the household. In doing this, they make a generally accepted assumption that the head is the single most important person in the household in terms of determining its economic and decision-making structure as well as its overall demographic composition. The NSA adopted this assumption in order to describe rural households more completely.)

Sex of head

For the most part, men were designated as the heads of rural households. However, in 4.1 million rural households (18.7 percent), women were designated as heads. This represented a 3.8 percent increase of female heads of households since the 1970 census.

Table III-6
Length of Residence in Present Unit

Years of Residence in Present Unit	Nation	
	Number of Households	Percent of Households
One year or less	5,154,000	23.4
2 - 5 years	6,081,000	27.7
6 - 10 years	3,527,000	16.1
11 - 15 years	1,957,000	8.9
16 - 20 years	1,359,000	6.2
21 - 25 years	1,292,000	5.9
26 years or longer	2,598,000	11.8
Unknown	6,000	0.0
Total	21,974,000	100.0

Each figure in the table is rounded independently; numbers and percentages may not equal rounded totals.

Ethnicity of head

In very close agreement with the 1970 census and the estimates from the 1976 Annual Housing Survey, the NSA found that over 90 percent of the heads of occupied rural households were of white ethnic status. In particular, 20.1 million households (91.3 percent) reported the ethnicity of the head as white. Approximately 1.3 million household heads (5.9 percent) were designated as black, and 612,000 (2.8 percent) were from other ethnic groups (Hispanic, American Indian, Alaskan native, or Asian or Pacific Islander). Altogether, there were 1.9 million nonwhite household heads (8.7 percent, combined) in rural areas of the US.

Age of head

Since the 1970 census, there has been a shift to younger age groups among heads of rural households, which in part may reflect the influx during the 1970s of young people into the rural nonfarm population. In late 1978, approximately 30 percent of rural household heads were 34 years of age or younger. An additional 21.2 percent, representing approximately 4.7 million households, were between 35 and 44 years of age. These figures represent increases in both age categories since 1970. By contrast, 28.7 percent of rural household heads (6.3 million) were between 45 and 64 in 1978, down from 37.3 percent in 1970. About 20 percent of rural household heads were 65 or older. (Details are in Table III-7.) The median age for heads of occupied rural household units was estimated to be 44.0 years. In 1970, the median was 49.0 years. Comparable data were not reported in the 1976 Annual Housing Survey.

Years of schooling completed by head

Some heads of rural households had no formal schooling at all. Others had four or more years of college. About one-third had one or more years of college, but a little over one-fifth had only eight years or less of formal education (see

Table III-7
Age of Head

Age	Nation Number of Households	 Percent of Households
18 - 24 years	1,419,000	6.5
25 - 34 years	5,066,000	23.1
35 - 44 years	4,661,000	21.2
45 - 64 years	6,315,000	28.7
65 and over	4,489,000	20.4
Unknown	23,000	0.1
Total	21,973,000	100.0

Each figure in the table is rounded independently; numbers and percentages may not equal rounded totals.

Table III-8). The median number of years completed was twelve. In 1970, the median number of years of formal schooling was 10.7; in 1976 it was an estimated 11.7. These comparisons indicated a trend towards increased education among heads of rural households.

Employment status of head

Approximately 15.5 million heads of rural households (70.5 percent) were working full time or part time during the week prior to the NSA interview; 4.6 million (21.1 percent) were retired; 625,000 (2.8 percent) were unemployed; and 4.8 percent (approximately one million household heads) were keeping house without pay. A small fraction (0.7 percent) were full-time students.

The proportion of household heads who indicated they were unemployed may seem small in comparison with national unemployment levels in 1978, but it reflects only the employment patterns of household heads, not of the full work force. Conventional unemployment figures, such as those reported by the news media, are compiled by the Bureau of Labor Statistics, which bases its tabulations on all people in the work force who are sixteen or older. The NSA finding of 2.8 percent unemployment closely conforms with the 1970 census finding of 2.3 percent unemployment among heads of rural households.

When the six categories of employment status were reduced to two—employed and not employed—the NSA results closely paralleled those of the 1976 Annual Housing Survey (see Appendix B).

An interesting sidelight of employment status was discovered in the NSA data: in approximately 3.7 million households (17.6 percent), the head of the household had a second job.

Table III-8
Years of Schooling Completed by Head

	Nation	
Years Completed	Number of Households	Percent of Households
No years completed	145,000	0.7
Less than 8 years	2,189,000	10.0
8 years	2,341,000	10.7
1-3 years high school	3,056,000	13.9
4 years high school	6,788,000	30.9
1-3 years college	3,545,000	16.1
4 or more years college	3,860,000	17.6
Unknown	50,000	0.2
Total	21,974,000	100.1

Each figure in the table is rounded independently; numbers and percentages may not equal rounded totals.

Occupation of head

Table III-9 presents the occupational distribution of rural household heads. It shows that, of the approximately 15.8 million working household heads, 38.1 percent (six million) were craftsmen, machine operators, or transportation equipment operators. These proportions were lower than those compiled in the 1970 census. Approximately 1.5 million household heads were in sales or clerical occupations. This 9.7 percent was close to the proportion found in these occupations in the 1970 census.

The table also shows that 33.3 percent of the heads of rural households—about 5.3 million—had primary occupations categorized as either professional and technical, or managerial and administrative (excluding farming). This proportion was rather high compared to the 1970 census. The two categories related to farming showed the greatest discrepancies with the 1970 census, however. The NSA recorded 1.4 million rural household heads (8.6 percent) in these two categories combined, compared to 14.0 percent of family heads found in these categories in the 1970 census. The deviation in these farm occupation categories may have been partly a function of NSA sampling and coding error, but also may have reflected two trends in agriculture—the decline of small farms and the decline of farm labor due to increased mechanization. The most significant factor in the discrepancy, however, was probably that a disproportionate number of marginal farms happened to be included in the NSA sample.

REGIONAL VARIATION IN DEMOGRAPHIC PROFILE

The demographic profile discussed so far is a representative assessment of rural households and their heads at the national level. However, it does not reflect the many possible variations in population and housing dynamics that occur in an area as large as the continental US. To highlight those differences, NSA household data were grouped according to region, according to a household's location within

Table III-9

Occupation of Household Head

Occupation	Nation	
	Number of Heads	Percent of Heads
Professional, technical, and kindred	2,486,000	15.7
Managers, administrators, except farm	2,777,000	17.6
Sales workers	738,000	4.7
Clerical and kindred	785,000	5.0
Craftsmen and kindred	3,192,000	20.2
Operatives, except transportation	1,860,000	11.8
Transportation and equipment operatives	957,000	6.1
Laborers, except farm	749,000	4.7
Farmers and farm managers	1,148,000	7.3
Farm laborers and foremen	209,000	1.3
Service, except private household	880,000	5.6
Private household	9,000	0.0
*Total	15,790,000	100.0

*Table includes only those household heads who were employed full time or part time.

Each figure in the table is rounded independently; numbers and percentages may not equal rounded totals.

or outside of an SMSA, and according to size of place. As indicated earlier in this chapter, these groupings were expected to show differences in many aspects of water supply, consumption patterns, and water quality. These groupings formed the major bases for stratification and selection of the NSA household sample.

The regional groupings of NSA data correspond exactly with the regions used by the Bureau of the Census and other federal agencies (see Figure II-1 for their boundaries). Comparisons of subnational NSA data with the 1970 census and the 1976 Annual Housing Survey can be found in detail in Appendix B.

REGIONAL VARIATION IN ATTRIBUTES OF RURAL HOUSEHOLDS

Regional variation in number of occupied rural housing units

The NSA sampled the four broad census regions proportionately with regard to rural population and the number of occupied rural housing units. (Sampling was based on 1970 census data.) As seen in Table III-10, the South had the highest proportion of the rural population (42.3 percent of the total, or 9.3 million occupied rural households). The North Central contained 6.2 million rural households, or 28.3 percent, while the Northeast had 3.7 million (16.8 percent). The West had the lowest proportion of rural households (12.6 percent, or 2.8 million).

Regional variation in number of farm and nonfarm occupied units

Nationally, about 3.7 million rural households (16.9 percent) either owned or leased a farm, while 18.3 million did not. However, only 2.6 million (11.8 percent) received any income from the sale of farm products.

The proportion of households owning or leasing farms varied considerably from region to region. The Northeast contained the fewest rural farm households, both in absolute numbers and proportions. It had about 305,000 households which owned or leased a farm, representing 8.3 percent of all occupied rural units in that region, although only 149,000 received income from sale of farm products. The

Table III-10
Rural Occupied Housing Units in Each Region

Region	Occupied Housing Units Number	Occupied Housing Units Percent
Northeast	3,693,000	16.8
North Central	6,213,000	28.3
South	9,291,000	42.3
West	2,777,000	12.6
Total	21,974,000	100.0

North Central contained the greatest proportion of households owning or leasing a farm—22.8 percent of all occupied rural units in the region, or 1.4 million households, although only 1.1 million received income from farm sales. While the South contained the greatest absolute number of households either owning or leasing a farm (about 1.5 million or 16.1 percent of all occupied rural units in that region), only 992,000 had some income from farm sales. The West was estimated to have 491,000 households owning or leasing a farm (17.7 percent of all occupied rural units in the West) but of these, only 331,000 received income from farm sales.

These variations reflected the general regional pattern of agricultural productivity and involvement in farming during the last decade. That is, the North Central and West have tended to be more heavily involved in agriculture during the last decade than has the Northeast. The South has lagged slightly behind the North Central and the West in the proportion of farm households.

Regional variation in number of units in structure

Nationwide, the overwhelming majority of occupied units in rural areas—93.7 percent—were one-unit structures, if both conventional housing and mobile homes are counted together. Regions did show substantial variation in the proportions of different types of units, however (see Table III-11). The proportions of conventional one-unit structures (always the dominant category) varied by approximately ten percentage points across regions, from a high of 86.2 percent of all rural units in the North Central to a low of 77.0 percent in the West. Likewise, proportions of mobile homes and trailers varied by ten percentage points: the South had the greatest proportion of mobile homes and trailers (16.3 percent), while the Northeast had the smallest (5.7 percent).

Variation in the proportions of multiunit structures was considerably smaller; these structures were not very common in rural areas of any region. The Northeast had the greatest proportion of multiunit structures (11.5 percent of all

Table III-11

Regional Variation in Number of Units in Structure

Number of Units in Structure	Number and Percent of Households			
	Northeast	North Central	South	West
1 unit, conventional	3,060,000 82.8%	5,355,000 86.2%	7,336,000 78.9%	2,138,000 77.0%
Mobile home or trailer	209,000 5.7%	560,000 9.0%	1,511,000 16.3%	420,000 15.1%
2-4 units	190,000 5.1%	223,000 3.6%	56,000 0.6%	47,000 1.7%
5 or [illegible] units	235,000 6.4%	75,000 1.2%	388,000 4.2%	172,000 6.2%
Total	3,693,000 100.0%	6,213,000 100.0%	9,291,000 100.0%	2,777,000 100.0%

Each figure in the table is rounded independently; numbers and percentages may not equal rounded totals.

occupied rural units); the West had the second highest, with 7.9 percent; and the North Central and West had the fewest, with 4.8 percent each.

Regional variation in number of persons in household

While the median number of persons per occupied rural household was 2.6 for the nation as a whole, there were small variations from this figure among the four regions. For the Northeast, the median was 2.8; for the South, it was 2.7; and for the North Central, the median was 2.6. The West had the lowest median, 2.5.

There was little variation across regions in the various sizes of households, with the exception of the West. As can be seen in Table III-12, the West had a higher proportion of two-person households and households with seven or more persons than did any of the other three regions. On the other hand, the West was lower in the proportion of three- through six-person households. The patterns were similar to each other among the other three regions, except that two-person households were somewhat less common in the Northeast.

Regional variation in housing tenure (ownership arrangements)

Nationally, 80 percent of all rural housing units were owner-occupied. The other 20 percent were rented or had some other arrangement—the unit was leased from a family, or offered in exchange for labor, or occupied free of any rent. Except for the West, each region showed virtually identical patterns of tenure arrangements, differing by less than 1 percent in each category. In the West, a slightly smaller proportion of rural housing units were owner-occupied (77.2 percent), while a larger proportion were renter-occupied—21.4 percent, or 594,000.

Table III-12

Regional Variation in Number of Persons in Household

Number of Persons	Number and Percent of Households			
	Northeast	North Central	South	West
1 person	552,000 14.9%	863,000 13.9%	1,202,000 12.9%	338,000 12.2%
2 persons	1,093,000 29.6%	2,111,000 34.0%	3,169,000 34.1%	1,043,000 37.5%
3 persons	759,000 20.5%	1,153,000 18.6%	1,739,000 18.7%	492,000 17.7%
4 persons	666,000 18.0%	1,126,000 18.1%	1,659,000 17.9%	422,000 15.2%
5 persons	349,000 9.4%	489,000 7.9%	877,000 9.4%	202,000 7.3%
6 persons	201,000 5.5%	297,000 4.8%	403,000 4.3%	108,000 3.9%
7 or more	74,000 2.0%	174,000 2.8%	241,000 2.6%	172,000 6.2%
Total	3,693,000 99.9%	6,213,000 100.1%	9,291,000 99.9%	2,777,000 100.0%

Each figure in the table is rounded independently; numbers and percentages may not equal rounded totals.

Regional variation in household income

Regional variation in nonfarm income

For the nation, the median household income (for all members of the household, combined) from nonfarm sources was $13,000. In a regional comparison of nonfarm income, the medians showed noteworthy differences: $15,502 for the Northeast, $15,000 for the West, $12,000 for the South, and $12,001 for the North Central. The South and North Central were closest to the national median, while the medians for the Northeast and West were markedly higher. Moreover, there was a $3,502 difference between the medians for the Northeast and the South. Regional income statistics are presented in Table III-13. Unfortunately, for various reasons, income from nonfarm sources was not reported for a large proportion of households in the South (10.7 percent), which makes the percentage distribution and the median income somewhat less reliable for the South than for the other regions.

Also, there appeared to be meaningful regional variation in the proportions of households with no nonfarm income. The North Central contained a larger proportion of households with no nonfarm income (3.8 percent, compared to less than 2 percent in each of the other three regions). Presumably, this was the result of a larger proportion of rural households in the North Central deriving income exclusively from farming.

Regional variation in gross farm income (farm sales)

Striking differences were evident among the four regions of the US in income from farm sales. These differences probably reflected regional differences in farm size, type of farming operation, soil conditions, products sold, and market values for farm products. Nationally, 28.1 percent of households reporting some income from farm sales indicated gross income of less than $5,000, while 21.4 percent reported gross income of $20,000 or more (see Table III-3).

Table III-13
Regional Variation in Nonfarm Income

	Number and Percent of Households			
Income	Northeast	North Central	South	West
No nonfarm income	41,000 1.1%	236,000 3.8%	186,000 2.0%	53,000 1.9%
$1-2,999	91,000 2.5%	370,000 6.0%	599,000 6.4%	55,000 2.0%
$3,000-3,999	111,000 3.0%	300,000 4.8%	411,000 4.4%	152,000 5.5%
$4,000-4,999	114,000 3.1%	132,000 2.1%	281,000 3.0%	33,000 1.2%
$5,000-5,999	124,000 3.4%	148,000 2.4%	328,000 3.5%	66,000 2.4%
$6,000-6,999	149,000 4.0%	162,000 2.6%	384,000 4.1%	120,000 4.3%
$7,000-7,999	128,000 3.5%	151,000 2.4%	349,000 3.8%	114,000 4.1%
$8,000-9,999	134,000 3.6%	339,000 5.5%	611,000 6.6%	254,000 9.1%
$10,000-12,499	441,000 11.9%	1,071,000 17.2%	1,118,000 12.0%	339,000 12.2%
$12,500-14,999	254,000 6.9%	341,000 5.5%	566,000 6.1%	151,000 5.4%
$15,000-19,999	544,000 14.7%	816,000 13.1%	1,250,000 13.5%	308,000 11.1%
$20,000-24,999	576,000 15.6%	576,000 9.3%	800,000 8.6%	305,000 11.0%
$25,000-34,999	521,000 14.1%	687,000 11.1%	753,000 8.1%	340,000 12.3%
$35,000 or more	343,000 9.3%	393,000 6.3%	661,000 7.1%	432,000 15.5%
Unknown	123,000 3.3%	491,000 7.9%	994,000 10.7%	58,000 2.1%
Total	3,693,000 100.0%	6,213,000 100.0%	9,291,000 99.9%	2,777,000 100.1%

Each figure in the table is rounded independently; numbers and percentages may not equal rounded totals.

Regional data, presented in Table III-14, showed very different levels of farm income in the four regions. Gross farm income of less than $5,000 was reported by 60.8 percent of households having some farm income in the Northeast, compared to 38.3 percent in the South, 23.0 percent in the West, and only 18.5 percent in the North Central. At the other end of the scale, incomes of $20,000 or more were reported by 29.9 percent of households with some farm income in the North Central, 25.1 percent in the West, 18.8 percent in the Northeast, and only 11.9 percent in the South. These differences coincide with large-scale, high-yield farms being more common in the North Central and West.[2]

Unfortunately, sizable proportions of households in the North Central, South, and West did not report specific levels of income from farm sales, and it could not be determined how the missing information affected the regional distributions.

Regional variation in net farm income

Regional variation in net farm income (see Table III-15) followed the same distribution pattern as just described for gross farm income. For the nation, of those households reporting some income from farm sales, one-third indicated a net farm income of less than $2,500. Compared to the national estimate, the proportions reporting net farm income of less than $2,500 were significantly higher in the Northeast and South (58.6 percent and 40.2 percent, respectively) and lower in the North Central and West (26.8 percent and 27.3 percent, respectively).

At the national level, of those households reporting income from farm sales, 8.0 percent had net farm income of $20,000 or more. Estimates for three of the four regions showed about the same proportions in this range—6.3 percent in the Northeast, 8.5 percent in the North Central, and 4.2 percent in the South. In the West, however, 17.9 percent reported net farm income of $20,000 or more.

Table III-14

Regional Variation in Gross Farm Income (Farm Sales)

	Number and Percent of Households			
Income/Sales	Northeast	North Central	South	West
$1-2,499	47,000 42.0%	126,000 11.2%	282,000 28.5%	52,000 15.7%
$2,500-4,999	21,000 18.8%	82,000 7.3%	97,000 9.8%	24,000 7.3%
$5,000-9,999	19,000 17.0%	77,000 6.8%	116,000 11.7%	92,000 27.8%
$10,000-19,999	0 0.0%	115,000 10.2%	102,000 10.3%	29,000 8.8%
$20,000-39,999	0 0.0%	143,000 12.7%	32,000 3.2%	17,000 5.1%
$40,000-99,999	15,000 13.4%	135,000 12.0%	57,000 5.8%	24,000 7.3%
$100,000 or more	6,000 5.4%	58,000 5.2%	29,000 2.9%	42,000 12.7%
Unknown	41,000 3.6%	390,000 34.6%	276,000 27.9%	51,000 15.4%
*Total	149,000 100.2%	1,126,000 100.0%	992,000 100.1%	331,000 100.1%

*Table excludes households which had no income from the sale of farm products.

Each figure in the table is rounded independently; numbers and percentages may not equal rounded totals.

Table III-15

Regional Variation in Net Farm Income

Income	Number and Percent of Households			
	Northeast	North Central	South	West
Less than $1	15,000 10.4%	134,000 11.9%	152,000 15.4%	48,000 14.4%
$1-2,499	72,000 48.2%	168,000 14.9%	246,000 24.8%	43,000 12.9%
$2,500-4,999	0 0.0%	33,000 2.9%	124,000 12.4%	20,000 6.1%
$5,000-9,999	0 0.0%	175,000 15.6%	89,000 9.0%	86,000 26.1%
$10,000-19,999	11,000 7.5%	150,000 13.3%	79,000 7.9%	32,000 9.6%
$20,000-39,999	4,000 2.4%	73,000 6.5%	24,000 2.4%	32,000 9.7%
$40,000-99,999	0 0.0%	23,000 2.0%	6,000 0.6%	19,000 5.8%
$100,000 or more	6,000 3.9%	0 0.0%	11,000 1.2%	8,000 2.4%
Unknown	41,000 27.6%	371,000 32.9%	262,000 26.4%	43,000 13.0%
*Total	149,000 100.0%	1,126,000 100.0%	992,000 100.1%	331,000 100.0%

*Table excludes households which had no income from the sale of farm products.

Each figure in the table is rounded independently; numbers and percentages may not equal rounded totals.

Again, in every region but the West, over one-fourth of the households reporting some farm sales did not report a specific net farm income. This fact, in conjunction with the difficulty of interpreting net farm income data, makes it difficult to draw conclusions about net farm income findings.

Regional variation in total household income

When income from nonfarm sources was added to the net farm income for those households involved in farming, and new income distributions were compiled for all households, approximately the same percentages of households fell into the thirteen income categories as were reported for nonfarm income (see Table III-16). Because of the high proportion of farm households not having a reported net farm income, this compilation had more households in each region falling into the "unknown" or "not reported" category. The large number of unknowns resulted in less reliable computations of summary statistics like medians, so comparisons among these statistics are not discussed here.

Regional variation in length of residence

Nationally, the median length of residence among heads of rural households was 5.2 years. About 23.4 percent of rural household heads had lived in their homes one year or less. Heads in 17.7 percent of rural households had lived there continuously for more than twenty years. There was considerable variation among the four geographic regions in the median length of residence.

Median length of residence was shortest in the West—3.8 years. This reflected the general pattern of recent migration to the western states. As further evidence of this pattern of recent occupancy in the West, only 13.4 percent of the units there had been occupied by the present household head for more than fifteen years, whereas the comparable percentages for the other regions were almost double that (see Table III-17).

Table III-16

Regional Variation in Total Household Income

Income	Number and Percent of Households			
	Northeast	North Central	South	West
Less than $3,000	109,000 2.9%	342,000 5.5%	658,000 7.1%	85,000 3.1%
$3,000-3,999	111,000 3.0%	271,000 4.4%	356,000 3.8%	152,000 5.5%
$4,000-4,999	114,000 3.1%	132,000 2.1%	267,000 2.9%	33,000 1.2%
$5,000-5,999	104,000 2.8%	153,000 2.5%	315,000 3.4%	49,000 1.8%
$6,000-6,999	141,000 3.8%	126,000 2.0%	400,000 4.3%	107,000 3.9%
$7,000-7,999	141,000 3.8%	161,000 2.6%	331,000 3.6%	114,000 4.1%
$8,000-9,999	139,000 3.8%	319,000 5.1%	571,000 6.1%	276,000 9.9%
$10,000-12,499	452,000 12.2%	1,044,000 16.8%	1,195,000 12.9%	319,000 11.5%
$12,500-14,999	242,000 6.6%	373,000 6.0%	563,000 6.1%	135,000 4.9%
$15,000-19,999	544,000 14.7%	861,000 13.9%	1,261,000 13.6%	318,000 11.4%
$20,000-24,999	571,000 15.5%	551,000 8.9%	802,000 8.6%	292,000 10.5%
$25,000-34,999	518,000 14.0%	697,000 11.2%	761,000 8.2%	329,000 11.9%
$35,000 or more	353,000 9.6%	461,000 7.4%	653,000 7.0%	485,000 17.5%
Unknown	154,000 4.2%	721,000 11.6%	1,156,000 12.4%	84,000 3.0%
Total	3,693,000 100.0%	6,213,000 100.0%	9,291,000 100.0%	2,777,000 100.2%

Each figure in the table is rounded independently; numbers and percentages may not equal rounded totals.

Table III-17

Regional Variation in Length of Residence of Household Head

Years of Residence in Present Unit	Number and Percent of Households			
	Northeast	North Central	South	West
1 year or less	762,000 20.6%	1,312,000 21.1%	2,251,000 24.2%	829,000 29.9%
2-5 years	940,000 25.4%	1,889,000 30.4%	2,411,000 25.9%	842,000 30.3%
6-10 years	674,000 18.2%	903,000 14.5%	1,551,000 16.7%	400,000 14.4%
11-15 years	406,000 11.0%	466,000 7.5%	750,000 8.1%	335,000 12.0%
16-20 years	161,000 4.4%	412,000 6.6%	710,000 7.6%	76,000 2.7%
21-25 years	234,000 6.3%	413,000 6.6%	507,000 5.5%	138,000 5.0%
26 years or longer	511,000 13.8%	818,000 13.2%	1,111,000 12.0%	158,000 5.7%
Unknown	6,000 0.2%	0 0.0%	0 0.0%	0 0.0%
Total	3,693,000 99.9%	6,213,000 99.9%	9,291,000 100.0%	2,777,000 100.0%

Each figure in the table is rounded independently; numbers and percentages may not equal rounded totals.

In contrast to the West, the Northeast contained the highest proportion of long-time residents: the median number of years the present head had occupied the unit was 6.3 years, more than one year longer than the national median, and nearly a year longer than the closest median value in the other three regions. The Northeast also had the largest proportion of rural household heads who had moved into their present units between 1970 and 1974 (six to ten years prior to the NSA), whereas the other three regions had the greatest percentage of heads moving into the present housing units between 1975 and 1977 (two through five years prior to the NSA).

The South and North Central had similar profiles of length of residence, with respective medians of 5.5 and 5.2 years. Patterns in these two regions were very similar to national patterns.

In spite of these differences, one common feature was that in each region, over 50 percent of rural household heads had lived in their present units less than seven years. This finding contrasted sharply with the conventional notion of a stable rural population with citizens living in the same houses for decades. However, the NSA study included both farm and nonfarm households, and nonfarm heads probably accounted for the predominance of recent movers.

REGIONAL VARIATION IN ATTRIBUTES OF HOUSEHOLD HEADS

Regional variation in sex of head

In the nation and in each of the four regions, about four-fifths of rural household heads were male.. The respective percentages for the four regions were: Northeast, 79.7; North Central, 82.6; South, 81.3; and West, 80.4. Although little variation occurred across the regions, it should be noted that in each region the NSA recorded a higher percentage of female household heads than did the 1970 Census of Population. This may have reflected an increasing number of female spouses reporting head or co-head status. It may also have reflected an increase in single-parent households with female heads.

Regional variation in ethnicity of head

In 91.3 percent of rural US households (20.1 million), the household head was white. In 5.9 percent, the household head was black. In the remaining 2.8 percent, heads were from other ethnic groups (Hispanic or American Indian, for the most part).

Regionally, there was considerable variation in the ethnicity of household heads (see Table III-18). The proportion of rural household heads designated as white ranged from 85.1 percent in the South to 98.9 percent in the North Central, a difference of almost 14 percent.

The Northeast and North Central resembled each other in ethnicity patterns. Both had less than 1 percent of heads designated as black and less than 2 percent from other ethnic groups.

The South and West had approximately the same proportion of heads identified as white (85.1 percent and 87.1 percent), but differed in the proportions of heads who were black or from other ethnic groups. As might be expected, the South had a greater proportion of blacks—12.3 percent of all rural household heads in that region, compared to 4.0 percent in the West. The West, on the other hand, had a large proportion of household heads from other ethnic groups—8.9 percent, compared to 2.5 percent in the South (this reflected the large Hispanic population in the southwestern part of the United States). Combined, all nonwhite household heads numbered 1.4 million in the South (14.8 percent); 358,000 in the West (12.9 percent); 99,000 in the Northeast (2.7 percent); and 68,000 in the North Central (1.1 percent).

Table III-18

Regional Variation in Ethnicity of Head

	Number and Percent of Households			
Ethnicity	Northeast	North Central	South	West
White	3,594,000 97.3%	6,145,000 98.9%	7,909,000 85.1%	2,419,000 87.1%
Black	34,000 0.9%	7,000 0.1%	1,142,000 12.3%	111,000 4.0%
Other	65,000 1.8%	61,000 1.0%	232,000 2.5%	246,000 8.9%
Unknown	0 0.0%	0 0.0%	8,000 0.1%	0 0.0%
Total	3,693,000 100.0%	6,213,000 100.0%	9,291,000 100.0%	2,777,000 100.0%

Each figure in the table is rounded independently; numbers and percentages may not equal rounded totals.

Regional variation in age of head

At first glance, Table III-19 seems to indicate some potentially significant regional differences in age of rural household heads. In the Northeast and South, for example, less than 6 percent of heads were in the 18- to 24-years-of-age category. Moreover, in the Northeast only 15.4 percent of heads were 65 or older—more than 5 percent less than in the other regions.

On the other hand, Table III-19 shows considerable regional consistency in the three middle age categories. The regional median age of heads deviated by approximately one year from the national median, and roughly two years from region to region. Specifically, the national median was 44.0 years of age, and the regions had the following medians: 42.6 for the Northeast, 43.5 for the North Central, 45.0 for the South, and 43.6 for the West. This indicated that there were no significant age differences among the four regions.

Regional variation in years of schooling completed by head

While there was not much regional variation in the median years of schooling completed by heads of rural households, there were still some prominent regional differences in education levels. Thus, although medians were within a narrow range—a low of 11.7 years in the South, a high of 12.5 years in the West—16.8 percent of all rural heads in the South had either no education or less than an eighth-grade education (see Table III-20). At the other end of the education spectrum, in both the Northeast and the West, approximately 23 percent of all heads of rural households had four or more years of college education. By contrast, only 16.9 percent of heads in the South and 12.8 percent in the North Central had reached this level of formal education.

In summary, although the medians for years of schooling were fairly consistent for the regions, household heads in the West and Northeast apparently had more education than heads located in the North Central and South.

Table III-19

Regional Variation in Age of Head

Age	Number and Percent of Households			
	Northeast	North Central	South	West
18-24	170,000 4.6%	495,000 8.0%	548,000 5.9%	207,000 7.4%
25-34	995,000 27.0%	1,321,000 21.3%	2,096,000 22.6%	654,000 23.5%
35-44	775,000 21.0%	1,383,000 22.3%	1,947,000 21.0%	556,000 20.0%
45-64	1,173,000 31.8%	1,717,000 27.6%	2,670,000 28.7%	754,000 27.2%
65 or older	569,000 15.4%	1,296,000 20.9%	2,018,000 21.7%	606,000 21.8%
Unknown	11,000 0.3%	0 0.0%	12,000 0.1%	0 0.0%
Total	3,693,000 100.1%	6,213,000 100.1%	9,291,000 100.0%	2,777,000 99.9%

Each figure in the table is rounded independently; numbers and percentages may not equal rounded totals.

Table III-20

Regional Variation in Years of Schooling Completed by Head

	Number and Percent of Households			
Years Completed	Northeast	North Central	South	West
No years	3,000 0.1%	17,000 0.3%	86,000 0.9%	38,000 1.4%
Less than 8 years	154,000 4.2%	445,000 7.2%	1,482,000 15.9%	109,000 3.9%
8 years	344,000 9.3%	850,000 13.7%	1,005,000 10.8%	141,000 5.1%
1-3 years high school	427,000 11.6%	730,000 11.8%	1,584,000 17.1%	314,000 11.3%
4 years high school	1,336,000 36.2%	2,424,000 39.0%	2,249,000 24.2%	780,000 28.1%
1-3 years college	567,000 15.3%	942,000 15.2%	1,283,000 13.8%	753,000 27.1%
4 or more years college	863,000 23.4%	798,000 12.8%	1,566,000 16.9%	633,000 22.8%
Unknown	0 0.0%	6,000 0.1%	36,000 0.4%	8,000 0.3%
Total	3,693,000 100.1%	6,213,000 100.1%	9,291,000 100.0%	2,777,000 100.0%

Each figure in the table is rounded independently; numbers and percentages may not equal rounded totals.

Regional variation in employment status of head

In terms of employment status of household heads, the Northeast was most at variance with the nation and with other regions. Fully 78.9 percent of all household heads in that region were working full time or part time (see Table III-21). This was 8.4 percent higher than for the nation as a whole, 6.9 percent higher than for the North Central, 11.6 percent higher than for the South, and 12.0 percent higher than for the West.

Consistent with this pattern, the percentage of retired rural heads was considerably lower in the Northeast than in the other regions or the nation as a whole. Based on the NSA sample, it was estimated that 15.2 percent of all heads in the Northeast were retired. This was almost six percentage points lower than for the nation and approximately nine percentage points lower than for the South and the West, but only 3.5 percentage points lower than in the North Central.

All the other regions had at least twice as many unemployed heads as did the Northeast, where only 1.4 percent of rural household heads were unemployed. The West had the highest proportion of unemployed heads (4.7 percent), with the North Central and South having about 3 percent.

The percentage of unemployed rural household heads may seem low in view of overall national statistics for 1978, but national unemployment statistics are compiled for all persons sixteen years of age or older, while the NSA data pertain only to heads of rural households.

Regional variation in occupation of head

As was true at the national level (see the previous section in this chapter), a higher-than-expected proportion of rural household heads in all regions had professional, technical, managerial, or administrative occupations. Also, a lower-than-expected proportion in all regions had farming occupations (see Table III-22).

Table III-21

Regional Variation in Employment Status of Head

	Number and Percent of Households			
Employment Status	Northeast	North Central	South	West
Working full time	2,715,000 73.5%	4,125,000 66.4%	5,945,000 64.0%	1,681,000 60.5%
Working part time	200,000 5.4%	348,000 5.6%	309,000 3.3%	178,000 6.4%
Going to school	35,000 0.9%	37,000 0.6%	84,000 0.9%	0 0.0%
Keeping house	133,000 3.6%	348,000 5.6%	439,000 4.7%	127,000 4.6%
Retired	560,000 15.2%	1,163,000 18.7%	2,259,000 24.3%	661,000 23.8%
Unemployed	50,000 1.4%	191,000 3.1%	254,000 2.7%	130,000 4.7%
Total	3,693,000 100.0%	6,213,000 100.0%	9,291,000 99.9%	2,777,000 100.0%

Each figure in the table is rounded independently; numbers and percentages may not equal rounded totals.

Table III-22

Regional Variation in Occupation of Household Head

Occupation	Number and Percent of Households Northeast	 North Central	 South	 West
Professional, technical, and kindred	588,000 20.0%	573,000 12.6%	945,000 14.8%	380,000 19.8%
Managers, administrators, except farm	563,000 19.1%	769,000 16.9%	849,000 13.3%	595,000 31.0%
Sales workers	177,000 6.0%	224,000 4.9%	271,000 4.3%	65,000 3.4%
Clerical and kindred	214,000 7.3%	219,000 4.8%	304,000 4.8%	48,000 2.5%
Craftsmen and kindred	527,000 17.9%	925,000 20.4%	1,414,000 22.2%	326,000 17.0%
Operatives, except transportation	342,000 11.6%	478,000 10.5%	902,000 14.2%	139,000 7.2%
Transportation and equipment operatives	154,000 5.2%	300,000 6.6%	441,000 6.9%	61,000 3.2%
Laborers, except farm	136,000 4.6%	234,000 5.2%	309,000 4.8%	71,000 3.7%
Farmers and farm managers	56,000 1.9%	565,000 12.4%	427,000 6.7%	100,000 5.2%
Farm laborers and foremen	18,000 0.6%	30,000 0.7%	146,000 2.3%	15,000 0.8%
Service, except private household	173,000 5.9%	229,000 5.0%	357,000 5.6%	121,000 6.3%
Private household	0 0.0%	0 0.0%	9,000 0.1%	0 0.0%
*Total	2,948,000 100.1%	4,546,000 100.0%	6,374,000 100.0%	1,921,000 100.1%

*Table includes only those heads who were employed full time or part time.

Each figure in the table is rounded independently; numbers and percentages may not equal rounded totals.

Variations and trends in Table III-22 are in part related to NSA sampling and coding procedures, as discussed earlier in this chapter (see "Occupation of head"). The differences are discussed further in Appendix B. Because of these potential influences, the regional variations are presented without interpretation.

Summary, Regional variation in demographic profile

The four regions of the US had very different demographic profiles. In fact, regional differences were evident in all but five characteristics: the size of the household, household ownership (tenure), the sex of the household head, the age of the household head, and the amount of schooling completed by the household head.

The Northeast contained 16.8 percent of the nation's rural households, and by far the lowest proportion of households which owned or leased a farm (8.3 percent). Consistent with its large nonagricultural work force, the Northeast had the highest median nonfarm income of all regions ($15,502), but the lowest median values for gross farm and net farm income. Although a large proportion of its rural housing units were conventional one-unit structures, it also contained a large proportion of duplexes (two-unit structures) and apartment buildings in rural areas. The Northeast had the lowest proportion of mobile homes and trailers of any region, and showed the highest median value for length of residence. The region had the second highest proportion of white household heads—97.3 percent; this proportion was exceeded only in the North Central. The Northeast also had the highest proportion of household heads who were employed full time or part time.

The North Central contained 28.3 percent of all rural households in the US, and the highest proportion of households which owned or leased a farm (22.8 percent). Consistent with the importance of agriculture to the region, the North Central had the highest gross farm income, though only a moderately high net farm income, while the median nonfarm income was only $12,000 (similar to the South's).

Of all regions, the North Central contained the highest proportion of single-family dwelling units and, with the South, the lowest proportion of duplexes and apartment buildings in rural areas. The median length of residence in the North Central was the same as the national figure, 5.2 years. The region had the highest proportion of white heads of households, and the second highest proportion of household heads who were employed full time or part time.

The South had by far the greatest number of rural households (9.3 million, or 42.3 percent of all rural households in the US). Like the West, it had a moderate proportion of households which owned or leased a farm (16.1 percent); this proportion was higher than in the Northeast but lower than in the North Central. Income in the South was comparatively low, regardless of source. Along with the North Central, the South had the lowest nonfarm income, but the South also had low median values for gross farm and net farm income. Of all regions, the South had the highest proportion of mobile homes and trailers, and lower proportions than other regions of both conventional one-unit structures and multiunit structures. Median length of residence was about at the national level. The South had the highest proportion of household heads who were black and, together with the West, had the lowest proportion of household heads who were employed either full time or part time.

The West had the smallest proportion of US rural households (12.6 percent, or 2.8 million). A moderate proportion of households in the West (17.7 percent) either owned or leased a farm. Both gross farm income and net farm income were highest in the West, and the median figure for nonfarm income was exceeded only by the Northeast. Rural housing units in the West mostly consisted of conventional one-unit structures, but a comparatively high proportion were mobile homes and trailers. Median length of residence was lowest in the West, implying greater residential mobility. The West contained the highest proportion of household heads who were of Hispanic, American Indian, or other ethnic groups besides white and black. There was also a significant proportion of black household heads in the West; the proportion of white household heads was the second lowest. Finally, the West and the South had the same low proportions of household heads who were employed either full time or part time.

SMSA/NonSMSA VARIATION IN DEMOGRAPHIC PROFILE

In addition to aggregating household data by region, the NSA was designed to allow contrasts between rural households located inside and outside of SMSAs (see Figure II-2 for a map showing SMSAs in the continental US). SMSA/nonSMSA comparisons provided a different understanding of factors influencing household water conditions than was seen in the regional analysis. The assumption behind the SMSA/nonSMSA comparisons was that, since SMSAs contain at least one city of over 50,000 residents and are more densely populated areas, rural households located in these areas are under a different set of influences than households outside SMSAs, and have greater access to a broad range of services, including water supply. Consequently, it was expected that a greater proportion of rural households within SMSAs would be connected to large water supply and wastewater disposal systems. The purpose of the SMSA/nonSMSA contrast was to determine how and why water conditions in rural households within SMSAs might differ from water conditions in rural households located outside of SMSAs. Demographic attributes were compared in an attempt to discover how the various social impacts of urbanization affect rural households with regard to water supply.

The SMSA/nonSMSA dichotomy was constructed without regard to geographic region, just as the regional descriptive analysis was performed irrespective of the SMSA/nonSMSA grouping. That is, the analysis did not divide by region those households located within SMSAs and those located outside of SMSAs, since estimation at that level would not be reliable.

SMSA/NonSMSA VARIATION IN ATTRIBUTES OF RURAL HOUSEHOLDS

SMSA/nonSMSA variation in number of occupied rural housing units

Based on the NSA sample, in 1978 there were seven million rural households located inside SMSAs, or 32.0 percent of all rural households. Conversely, about 14.9 million rural households (68.0 percent) were located outside SMSAs.

SMSA/nonSMSA variation in farm and nonfarm occupied units

Of the seven million rural households which were inside SMSAs, 792,000 (11.3 percent of them) owned or leased a farm, while 6.2 million (88.7 percent) did not. As would be expected, a higher proportion of rural households located outside of SMSAs (19.5 percent, or 2.9 million) owned or leased farms, while about twelve million, or 80.5 percent, did not. From the perspective of farm sales, only 513,000 SMSA households had income from the sale of farm products, compared to 2.1 million nonSMSA households.

SMSA/nonSMSA variation in number of units in structure

More than four-fifths (81.4 percent) of rural dwelling units across the US were conventional single-unit structures, and there was virtually no difference found between SMSA housing and nonSMSA housing in this regard. Inside SMSAs, 81.0 percent (5.7 million units) were conventional one-unit structures; outside SMSAs, the proportion was 81.6 percent (12.2 million units). There was a much higher proportion of mobile homes outside SMSAs than inside SMSAs: 14.3 percent, or 2.1 million nonSMSA units, compared to 8.0 percent, or 561,000, SMSA units. (Nationally, 12.3 percent of all units were mobile homes.)

Within SMSAs, approximately 2.1 percent (145,000 units) were located in structures containing two, three, or four housing units, while 2.5 percent outside SMSAs (370,000) were located in such structures. As one would expect, the proportion of rural units that were located in structures containing five or more housing units was much higher inside SMSAs than outside. The difference—8.9 percent (628,000 units) within SMSAs, compared to 1.6 percent (240,000 units) outside SMSAs—reflected the housing patterns that evolve in areas of high population density close to large urban centers.

SMSA/nonSMSA variation in number of persons in household

As to the size of household, there was a notable difference between SMSA and nonSMSA rural households. Nationwide, the median number of persons per household was 2.6, with 13.4 percent being one-person households and 16.3 percent having five or more members. For SMSA households, however, the median number of persons was 3.0, while for nonSMSA households, the median was 2.5. The difference would be unexpected if one assumed that units located outside SMSAs were more rural and that rural households tended to be larger. As shown in Table III-23, however, SMSAs had a smaller proportion of one-person households and larger proportions of households with four, five, and six persons.

SMSA/nonSMSA variation in housing tenure (ownership arrangements)

Figures on housing ownership showed little variation between SMSA households and nonSMSA households. Nationally, 79.4 percent of all rural housing units were owner-occupied, with 17.8 percent being renter-occupied and 2.8 percent having other arrangements. Of those rural housing units located within SMSAs, 81.7 percent (5.8 million units) were owner-occupied, compared to 78.3 percent (11.7 million) located outside of SMSAs. The difference of three percentage points is probably not meaningful.

Likewise, it was estimated that 17.1 percent of rural households located inside SMSAs (1.2 million units) were renter-occupied, and that 18.2 percent outside SMSAs (2.7 million) were renter-occupied. Other sorts of arrangements

Table III-23

SMSA/NonSMSA Variation in Number of Persons in Household

Number of Persons in Household	Number and Percent of Households	
	SMSA	NonSMSA
1 person	834,000 11.8%	2,120,000 14.2%
2 persons	2,046,000 29.1%	5,369,000 36.0%
3 persons	1,375,000 19.5%	2,768,000 18.5%
4 persons	1,484,000 21.1%	2,389,000 16.0%
5 persons	740,000 10.5%	1,177,000 7.9%
6 persons	403,000 5.7%	607,000 4.1%
7 or more	157,000 2.2%	504,000 3.4%
Total	7,040,000 99.9%	14,934,000 100.1%

Each figure in the table is rounded independently; numbers and percentages may not equal rounded totals.

were in effect at 1.1 percent of housing units inside SMSAs and 3.5 percent of units outside SMSAs.

SMSA/nonSMSA variation in household income

SMSA/nonSMSA variation in nonfarm income

Income from nonfarm sources was expected to be higher among SMSA households than among nonSMSA households, due to the positive economic effects of urban centers. However, the difference found was larger than expected.

As reported earlier in this chapter, the median income of rural households across the US was $13,000. Nationwide, approximately one-fourth of rural households had income of less than $8,000 from nonfarm sources, while a little over one-fifth had income of $25,000 or more.

The comparison of SMSA and nonSMSA rural households revealed a stark contrast, shown in Table III-24. Median income for households located within SMSAs was $18,000; for households outside of SMSAs, it was $12,000. Thus, there was a $6,000 difference between the two medians. Other findings were that approximately 13 percent of rural households inside SMSAs had nonfarm income of less than $8,000, compared to over one-fourth of rural households outside of SMSAs. Likewise, 32.7 percent of rural households inside SMSAs earned $25,000 or more from nonfarm sources, whereas outside of SMSAs, only 12.3 percent did. Finally, as would be expected, only 0.5 percent of SMSA households reported no nonfarm income, compared to 3.2 percent of nonSMSA households.

SMSA/nonSMSA variation in gross farm income

More than one-fourth of both SMSA and nonSMSA households that derived income from the sale of farm products reported sales of less than $5,000 (see Table III-25). At the upper end of the scale, only 11.3 percent located inside SMSAs reported farm sales of $20,000 or more, while 23.9 percent outside of SMSAs had

Table III-24

SMSA/NonSMSA Variation in Nonfarm Income

	Number and Percent of Households	
Income	SMSA	NonSMSA
No nonfarm income	34,000 0.5%	481,000 3.2%
$1-2,999	237,000 3.4%	877,000 5.9%
$3,000-3,999	156,000 2.2%	817,000 5.5%
$4,000-4,999	61,000 0.9%	499,000 3.3%
$5,000-5,999	163,000 2.3%	502,000 3.4%
$6,000-6,999	137,000 1.9%	678,000 4.5%
$7,000-7,999	133,000 1.9%	608,000 4.1%
$8,000-9,999	174,000 2.5%	1,164,000 7.8%
$10,000-12,499	1,035,000 14.7%	1,934,000 12.9%
$12,500-14,999	307,000 4.4%	1,005,000 6.7%
$15,000-19,999	1,090,000 15.5%	1,826,000 12.2%
$20,000-24,999	855,000 12.1%	1,402,000 9.4%
$25,000-34,999	1,100,000 15.6%	1,202,000 8.1%
$35,000 or more	1,203,000 17.1%	627,000 4.2%
Unknown	355,000 5.1%	1,311,000 8.8%
Total	7,040,000 100.1%	14,934,000 100.0%

Each figure in the table is rounded independently; numbers and percentages may not equal rounded totals.

Table III-25

SMSA/NonSMSA Variation in Gross Farm Income (Farm Sales)

Income/Sales	Number and Percent of Households	
	SMSA	NonSMSA
$1-2,499	101,000 19.7%	407,000 19.5%
$2,500-4,999	52,000 10.1%	173,000 8.3%
$5,000-9,999	89,000 17.3%	216,000 10.4%
$10,000-19,999	63,000 12.2%	184,000 8.8%
$20,000-39,999	21,000 4.1%	170,000 8.1%
$40,000-99,999	33,000 6.4%	198,000 9.5%
$100,000 or more	4,000 0.8%	130,000 6.3%
Unknown	150,000 29.4%	608,000 29.2%
*Total	513,000 100.0%	2,087,000 100.1%

*Table excludes households which had no income from the sale of farm products.

Each figure in the table is rounded independently; numbers and percentages may not equal rounded totals.

gross farm income in this range. The differences in levels of gross farm income probably reflect differences in the type and size of farm operations, with farms located outside of SMSAs producing products in greater volume or of higher value. Almost 30 percent of both SMSA and nonSMSA households with income from farm sales did not report their income.

SMSA/nonSMSA variation in net farm income

The SMSA/nonSMSA comparison showed little variation from national findings in levels of net farm income. For the nation, about one-third of the households that derived some income from farm sales indicated a net farm income of less than $2,500. This range of net farm income was reported by 36.8 percent of SMSA households and 33.1 percent of nonSMSA households. At the upper end of the scale, only 4.8 percent of the SMSA households with some farm sales reported a net farm income of $20,000 or more, compared to 8.6 percent of the nonSMSA farm households (see Table III-26).

Though there was little variation evident in the comparison, it was evident that farm households located outside SMSAs had higher net farm incomes than farm households located inside SMSAs. (Gross farm income showed somewhat the same trend.) Again, a large proportion of households did not report specific data on net farm income.

SMSA/nonSMSA variation in total household income

When comparisons were made between SMSA and nonSMSA households for total household income, the pattern that emerged corresponded closely to the one presented in Table III-24 for nonfarm income. Therefore, no results are reported here on the distribution of total household income from all sources, both farm and nonfarm. The information can be found in Appendix B, however.

Table III-26
SMSA/NonSMSA Variation in Net Farm Income

Income	Number and Percent of Households SMSA	 NonSMSA
Less than $1	64,000 12.5%	286,000 13.7%
$1-2,499	125,000 24.3%	404,000 19.4%
$2,500-4,999	33,000 6.4%	143,000 6.9%
$5,000-9,999	88,000 17.1%	263,000 12.6%
$10,000-19,999	41,000 8.0%	231,000 11.1%
$20,000-39,999	24,000 4.8%	107,000 5.1%
$40,000-99,999	0 0.0%	48,000 2.3%
$100,000 or more	0 0.0%	25,000 1.2%
Unknown	138,000 26.9%	579,000 27.8%
*Total	513,000 100.0%	2,087,000 100.1%

*Table excludes households which had no income from the sale of farm products.

Each figure in the table is rounded independently; numbers and percentages may not equal rounded totals.

SMSA/nonSMSA variation in length of residence

Two notable differences were observed between SMSA and nonSMSA rural households regarding length of residence (see Table III-27). First, a greater proportion of nonSMSA household heads (19.7 percent, compared to 13.4 percent) had moved into the household more than twenty years ago. Second, there was a proportionally greater influx into SMSA rural households from 1974 through 1977 (two to five years prior to the NSA) than there was into nonSMSA rural households (32.7 percent, compared to 25.3 percent).

For the US, the median length of residence of the household head was 5.2 years. For rural households within SMSAs, the median length of residence was 4.1 years; outside of SMSAs, it was 5.9 years—a difference of almost two years.

SMSA/NonSMSA VARIATION IN ATTRIBUTES OF HOUSEHOLD HEADS

SMSA/nonSMSA variation in sex of head

The SMSA/nonSMSA comparison showed no differences as to the proportions of rural households with male and female heads. The percentages were identical to those calculated for the nation as a whole: 81.3 percent male and 18.7 percent female. Of the estimated 17.9 million male heads of rural households, 5.7 million were in SMSA households, and 12.2 million were in nonSMSA households. Likewise, of the 4.1 million female heads, 1.3 million were heads of households situated within SMSAs, and 2.8 million were in households outside SMSAs.

SMSA/nonSMSA variation in ethnicity of head

Different ethnicity patterns were evident for SMSA and nonSMSA rural households. Specifically, a higher proportion of SMSA households had heads who were designated white (94.5 percent, compared with 89.8 percent in nonSMSA households). Likewise, there were proportionally more black household heads among nonSMSA households—7.3 percent, compared to 2.9 percent within SMSAs.

Table III-27

SMSA/NonSMSA Variation in Length of Residence of Household Head

Years of Residence in Present Unit	Number and Percent of Households SMSA	NonSMSA
1 year or less	1,714,000 24.3%	3,440,000 23.0%
2-5 years	2,300,000 32.7%	3,781,000 25.3%
6-10 years	1,174,000 16.7%	2,353,000 15.8%
11-15 years	520,000 7.4%	1,437,000 9.6%
16-20 years	386,000 5.5%	973,000 6.5%
21-25 years	354,000 5.0%	938,000 6.3%
26 years or longer	593,000 8.4%	2,005,000 13.4%
Unknown	0 0.0%	6,000 0.0%
Total	7,040,000 100.0%	14,934,000 99.9%

Each figure in the table is rounded independently; numbers and percentages may not equal rounded totals.

Household heads were designated as belonging to other ethnic groups in about equal proportions—2.5 percent among SMSA households and 2.9 percent among nonSMSA households. (For the US, the proportions of rural household heads were 91.3 percent white, 5.9 percent black, and 2.8 percent other.) Altogether, there were 1.5 million nonwhite household heads among nonSMSA households (10.2 percent), compared to only 377,000 within SMSAs (5.4 percent).

SMSA/nonSMSA variation in age of head

Substantial age differences existed between SMSA and nonSMSA rural household heads, as shown in Table III-28. Outside of SMSAs, proportionately fewer household heads were between the ages of 25 and 44 (39.8 percent, compared to 53.7 percent), while a much greater proportion were 65 or older (23.7 percent, compared to 13.4 percent).

The median age for rural household heads within SMSAs was 40.5 years, compared to 47.3 years outside of SMSAs. (For the rural US as a whole, the median age of household heads was 44.0 years.)

SMSA/nonSMSA variation in years of schooling completed by head

It was reported earlier in this chapter that for all rural household heads, the median number of years of school completed was twelve—which is equivalent to four years of high school. No significant variation from this median was observed in the SMSA/nonSMSA comparison; within SMSAs, the median number of years completed was 12.4 years, while outside of SMSAs, the median was 11.8. Though this might imply only a slight tendency for heads of rural households located near urban centers and in densely populated areas to have more education, Table III-29 shows a much more striking pattern. Proportionally twice as many heads of nonSMSA rural households had eight years or less of schooling—25.4 percent, compared to 12.7 percent among household heads within SMSAs. More-

Table III-28

SMSA/NonSMSA Variation in Age of Household Head

Age	Number and Percent of Households SMSA	NonSMSA
18-24	403,000 5.7%	1,016,000 6.8%
25-34	1,901,000 27.0%	3,165,000 21.2%
35-44	1,879,000 26.7%	2,782,000 18.6%
45-64	1,901,000 27.0%	4,414,000 29.6%
65 or older	945,000 13.4%	3,544,000 23.7%
Unknown	11,000 0.2%	12,000 0.1%
Total	7,040,000 100.0%	14,934,000 100.0%

Each figure in the table is rounded independently; numbers and percentages may not equal rounded totals.

Table III-29

SMSA/NonSMSA Variation in Years of Schooling Completed by Household Head

Years Completed	Number and Percent of Households SMSA	 NonSMSA
No years completed	17,000 0.2%	128,000 0.9%
Less than 8 years	335,000 4.8%	1,854,000 12.4%
8 years	541,000 7.7%	1,800,000 12.1%
1-3 years high school	730,000 10.4%	2,326,000 15.6%
4 years high school	2,161,000 30.7%	4,628,000 31.0%
1-3 years college	1,328,000 18.9%	2,217,000 14.8%
4 or more years college	1,921,000 27.3%	1,939,000 13.0%
Unknown	8,000 0.1%	42,000 0.3%
Total	7,040,000 100.1%	14,934,000 100.1%

Each figure in the table is rounded independently; numbers and percentages may not equal rounded totals.

over, at the other end of the continuum, 46.2 percent of rural household heads within SMSAs had one or more years of college experience, compared to only 27.8 percent of nonSMSA rural household heads.

SMSA/nonSMSA variation in employment status of head

As with educational experience, there was a notable difference in the employment situation of heads of SMSA versus nonSMSA households. Specifically, a substantially higher proportion of heads of rural households within SMSAs had full-time or part-time work (78.8 percent versus 66.7 percent). On a national basis, 70.5 percent of all rural household heads had full-time or part-time jobs.

On the other hand, a much higher proportion of nonSMSA household heads were retired (24.4 percent, compared to 14.2 percent within SMSAs). This difference of over ten percentage points may reflect unequal employment opportunities in the two environments or the different patterns of age and education that were reported earlier.

Proportionately few heads of both SMSA and nonSMSA rural households were unemployed, going to school full time, or keeping house without pay (see Table III-30).

SMSA/nonSMSA variation in occupation of head

Table III-31 presents the SMSA/nonSMSA comparison of rural household heads' occupations. Given the previously mentioned problems with the tabulation of rural occupations, however, no detailed comments will be given here (see national data on "Occupation of head," above).

Summary, SMSA/nonSMSA variation in demographic profile

SMSA and nonSMSA rural households showed substantially different demographic profiles, differing in all characteristics except four: the number of units in

Table III-30

SMSA/NonSMSA Variation in Employment Status of Household Head

	Number and Percent of Households	
Employment Status	SMSA	NonSMSA
Working full time	5,241,000 74.4%	9,225,000 61.8%
Working part time	311,000 4.4%	725,000 4.9%
Going to school	127,000 1.8%	29,000 0.2%
Keeping house	246,000 3.5%	802,000 5.4%
Retired	1,001,000 14.2%	3,642,000 24.4%
Unemployed	115,000 1.6%	511,000 3.4%
Total	7,040,000 99.9%	14,934,000 100.1%

Each figure in the table is rounded independently; numbers and percentages may not equal rounded totals.

Table III-31

SMSA/NonSMSA Variation in Occupation of Household Head

Characteristic	Number and Percent of Households SMSA	Number and Percent of Households NonSMSA
Professional, technical, and kindred	1,359,000 23.9%	1,127,000 11.2%
Managers, administrators, except farm	1,163,000 20.5%	1,614,000 16.0%
Sales workers	354,000 6.2%	383,000 3.8%
Clerical and kindred	268,000 4.7%	517,000 5.1%
Craftsmen and kindred	1,122,000 19.7%	2,070,000 20.5%
Operatives, except transportation	535,000 9.4%	1,326,000 13.1%
Transportation and equipment operatives	183,000 3.2%	775,000 7.7%
Laborers, except farm	187,000 3.3%	563,000 5.6%
Farmers and farm managers	158,000 2.8%	990,000 9.8%
Farm laborers and foremen	28,000 0.5%	181,000 1.8%
Service, except private household	323,000 5.7%	557,000 5.5%
Private household	4,000 0.1%	6,000 0.1%
*Total	5,684,000 100.0%	10,109,000 100.2%

*Table includes only those household heads who were employed full time or part time.

Each figure in the table is rounded independently; numbers and percentages may not equal rounded totals.

the structure, ownership (tenure), sex of the household head, and the amount of schooling completed by the household head.

Among the approximately 14.9 million rural households located outside of SMSAs (68.0 percent of all rural households in the US), a higher proportion owned or leased a farm; median figures for gross and net farm income were higher, while the median for nonfarm income was lower. NonSMSA household size was smaller, and current residents tended to have lived in the dwelling unit longer. There was a greater proportion of blacks among nonSMSA household heads. Also, household heads tended to be older and were less likely to be employed full time or part time.

By contrast, proportionately fewer of the rural households located inside SMSAs (32.0 percent of all rural households in the US) owned or leased a farm; median figures for gross and net farm income were lower, but the median for nonfarm income was higher. Households tended to be larger and more mobile (length of residence in the dwelling unit was shorter). Fewer household heads were black. Further, household heads tended to be younger and were more likely to be employed either full time or part time.

SIZE-OF-PLACE VARIATION IN DEMOGRAPHIC PROFILE

In this section of the report, households are grouped according to population size. The comparison was based in part on the hypothesis that population size largely determined the types of water supplies serving rural households. Specifically, it was thought that the larger the population base, the more likely it would be that water would be provided by a community supply. To classify households, the NSA used the following size-of-place categories:

- large rural communities: places with a population of 1,000 through 2,499 people;
- small rural communities: places with a population of less than 1,000; and
- other rural areas: those not officially recognized as places by the US Bureau of the Census.

SIZE-OF-PLACE VARIATION IN ATTRIBUTES OF RURAL HOUSEHOLDS

Size-of-place variation in number of occupied rural housing units

Based on the NSA sample, in 1978 there were 2.4 million households located in large rural communities and 1.5 million in small rural communities. The vast majority of rural households—18.1 million—were located in other rural areas.

Size-of-place variation in number of farm and nonfarm occupied units

Other rural areas had the highest proportion of households either owning or leasing a farm—18.4 percent, or 3.3 million households. Of these, 997,000 households had no income from the sale of farm products. In large rural communities, 191,000 households (8.1 percent) either owned or leased a farm; 60,000 of these had no farm sales. In small communities, there were 184,000 households (12.2 percent) that either owned or leased a farm; however, 52,000 had no farm sales.

Size-of-place variation in number of units in structure

Nationwide, 81.4 percent of all rural housing units were conventional one-unit structures, and a difference of less than two percentage points was evident in the three size-of-place categories. Mobile homes represented a slightly higher proportion of housing units in other rural areas (12.8 percent, or 2.3 million) than they did in small rural communities (11.4 percent, or 172,000) or in large rural communities (9.0 percent, or 212,000).

As for multiunit structures, those with two through four units comprised 5.3 percent of housing units in large rural communities (125,000 units), and 5.2 percent in small rural communities (78,000), but only 1.7 percent in other rural areas (313,000). Structures with five or more units comprised 4.4 percent of housing units in other rural areas (794,000) and 2.8 percent in large rural communities (66,000), but were almost nonexistent in small rural communities (0.6 percent, or 9,000).

Size-of-place variation in number of persons in household

Table III-32 displays the differences in household size among the three categories of size of place. For the most part, large and small rural communities resembled each other closely in household size, although a larger proportion of households in small rural communities consisted of two-person households (41.0 percent, compared to 35.9 percent in large rural communities). The most striking difference was that households in other rural areas differed markedly from households in the other two categories. Proportionally, other rural areas had fewer one-person households (12.1 percent, or 2.2 million) and many more households with four or more people. When all households with four or more persons are grouped, it can be seen that they composed 35.7 percent of the households in other rural areas (about 6.5 million), but only 26.5 percent in large rural communities (629,000) and 24.7 percent in small rural communities (373,000). This difference in household size is also evident from a comparison of the median number of people in a household: 2.8 for other rural areas, and 2.3 for both large and small rural communities.

Size-of-place variation in housing tenure (ownership arrangements)

Nationally, 79.4 percent of all rural housing units, or 17.5 million, were owner-occupied; 17.8 percent, or 3.9 million, were renter-occupied; and 2.8 percent, or 616,000, had some other arrangement. Ownership patterns in both small rural communities and other rural areas closely resembled national estimates. However, large rural communities showed an overall ownership pattern that was notably different: a smaller proportion of households were owner-occupied

Table III-32

Size-of-Place Variation in Number of Persons in Household

Number of Persons in Household	Number and Percent of Households Large Rural Communities	 Small Rural Communities	 Other Rural Areas
1 person	493,000 20.8%	271,000 18.0%	2,190,000 12.1%
2 persons	850,000 35.9%	618,000 41.0%	5,947,000 32.9%
3 persons	397,000 16.8%	247,000 16.4%	3,499,000 19.3%
4 persons	313,000 13.2%	198,000 13.1%	3,362,000 18.6%
5 persons	191,000 8.0%	75,000 5.0%	1,651,000 9.1%
6 persons	95,000 4.0%	86,000 5.7%	828,000 4.6%
7 or more	30,000 1.3%	14,000 0.9%	618,000 3.4%
Total	2,369,000 100.0%	1,509,000 100.1%	18,095,000 100.0%

Each figure in the table is rounded independently; numbers and percentages may not equal rounded totals.

(72.9 percent or 1.7 million), and a larger proportion were renter-occupied (24.8 percent or 587,000).

Size-of-place variation in household income

Size-of-place variation in nonfarm income

Surprising differences in levels of nonfarm income among the three size-of-place categories can be seen in a careful examination of Table III-33. Income was markedly higher among households in other rural areas. For instance, 31.7 percent of households in other rural areas (5.7 million) had incomes of $20,000 or more, compared to 19.6 percent of households in large rural communities (465,000) and 12.8 percent of households in small rural communities (193,000). Further, 64.1 percent of households in other rural areas had incomes of $10,000 or more, compared to 49.2 percent of households in large rural communities and 54.6 percent in small rural communities. At the lower end of the distribution, and excluding households that reported no nonfarm income, only 13.7 percent of households in other rural areas (2.5 million households) had nonfarm income of less than $6,000, compared to 21.2 percent in large communities (503,000) and 22.3 percent in small communities (337,000). Consistent with this pattern, the median nonfarm income for households in other rural areas was $14,000, compared to $10,001 for large communities and $10,995 for small communities.

Size-of-place variation in gross farm income (farm sales)

Meaningful patterns of variation in farm sales emerged when farm households located in large rural communities, small rural communities, and other rural areas were compared. For example, in small communities, 39.0 percent of those households that indicated some income from the sale of farm products reported gross farm income of less than $5,000, while only 20.2 percent of such households in large communities and 28.0 percent in other rural areas had gross farm income

Table III-33
Size-of-Place Variation in Nonfarm Income

Income	Number and Percent of Households Large Rural Communities	 Small Rural Communities	 Other Rural Areas
No nonfarm income	74,000 3.1%	50,000 3.3%	392,000 2.2%
$1 - 2,999	187,000 7.9%	110,000 7.3%	817,000 4.5%
$3,000 - 3,999	193,000 8.1%	115,000 7.6%	666,000 3.7%
$4,000 - 4,999	66,000 2.8%	44,000 2.9%	450,000 2.5%
$5,000 - 5,999	57,000 2.4%	68,000 4.5%	541,000 3.0%
$6,000 - 6,999	54,000 2.3%	44,000 2.9%	717,000 4.0%
$7,000 - 7,999	117,000 4.9%	28,000 1.8%	597,000 3.3%
$8,000 - 9,999	216,000 9.1%	111,000 7.4%	1,011,000 5.6%
$10,000 - 12,499	363,000 15.3%	234,000 15.5%	2,372,000 13.1%
$12,500 - 14,999	116,000 4.9%	100,000 6.6%	1,096,000 6.1%
$15,000 - 19,999	223,000 9.4%	298,000 19.7%	2,396,000 13.2%
$20,000 - 24,999	187,000 7.9%	80,000 5.3%	1,989,000 11.0%
$25,000 - 34,999	187,000 7.9%	60,000 4.0%	2,054,000 11.4%
$35,000 or more	91,000 3.8%	53,000 3.5%	1,685,000 9.3%
Unknown	240,000 10.1%	115,000 7.6%	1,311,000 7.2%
Total	2,369,000 99.9%	1,509,000 99.9%	18,095,000 100.1%

Each figure in the table is rounded independently; numbers and percentages may not equal rounded totals.

in this range (see Table III-34). In the upper range, only 8.6 percent in small communities had farm sales of $20,000 or more, compared to much bigger proportions elsewhere—15.8 percent in large communities and 22.4 percent in other rural areas. Over two-fifths (42.1 percent) of the households in large communities that had income from farm sales reported sales between $5,000 and $20,000; comparable proportions were 15.8 percent in small communities and 20.4 percent in other rural areas.

Size-of-place variation in net farm income

Net farm income showed much the same pattern of variation as gross farm income when farm households in the three size-of-place categories were compared (see Table III-35). That is, over two-fifths (45.1 percent) of the households located in small rural communities which indicated some income from the sale of farm products reported low net farm income (less than $2,500). In large communities, only 18.2 percent of those households that indicated some income from the sale of farm products showed a net farm income of less than $2,500; in other rural areas, the proportion was 34.0 percent. In the upper range, no households in small communities which had some income from farm sales had net farm income of $20,000 or more, but 9.3 percent of those located in large communities and 8.3 percent in other rural areas did.

Size-of-place variation in total household income

When income from both farm and nonfarm sources was combined and figures compared for the three size-of-place categories, the proportions of households in each income group were virtually identical to the proportions shown in Table III-33 for nonfarm income alone. Therefore, data on total household income are not presented.

Table III-34

Size-of-Place Variation in Gross Farm Income (Farm Sales)

	Number and Percent of Households		
Income/Sales	Large Rural Communities	Small Rural Communities	Other Rural Areas
$1-2,499	17,000 13.3%	40,000 30.4%	450,000 19.3%
$2,500-4,999	9,000 6.9%	11,000 8.6%	204,000 8.7%
$5,000-9,999	6,000 4.9%	7,000 5.3%	291,000 12.5%
$10,000-19,999	49,000 37.2%	14,000 10.5%	184,000 7.9%
$20,000-39,999	0 0.0%	11,000 8.6%	180,000 7.7%
$40,000-99,999	8,000 6.5%	0 0.0%	223,000 9.5%
$100,000 or more	12,000 9.3%	0 0.0%	123,000 5.2%
Unknown	29,000 22.0%	48,000 36.6%	682,000 29.2%
*Total	131,000 100.1%	132,000 100.0%	2,336,000 100.0%

*Table excludes households which had no income from the sale of farm products.

Each figure in the table is rounded independently; numbers and percentages may not equal rounded totals.

Table III-35

Size-of-Place Variation in Net Farm Income

	Number and Percent of Households		
Income	Large Rural Communities	Small Rural Communities	Other Rural Areas
Less than $1	12,000 9.1%	44,000 33.4%	293,000 12.6%
$1-2,499	12,000 9.1%	16,000 11.7%	501,000 21.4%
$2,500-4,999	47,000 35.4%	6,000 4.3%	124,000 5.3%
$5,000-9,999	0 0.0%	23,000 17.2%	328,000 14.0%
$10,000-19,999	20,000 15.2%	11,000 8.6%	241,000 10.3%
$20,000-39,999	6,000 4.9%	0 0.0%	126,000 5.4%
$40,000-99,999	0 0.0%	0 0.0%	48,000 2.1%
$100,000 or more	6,000 4.4%	0 0.0%	19,000 0.8%
Unknown	29,000 22.0%	33,000 24.7%	655,000 28.1%
*Total	131,000 100.1%	132,000 99.9%	2,336,000 100.0%

*Table excludes households which had no income from the sale of farm products.

Each figure in the table is rounded independently; numbers and percentages may not equal rounded totals.

Size-of-place variation in length of residence

For length of residence, there was very little variation from national estimates among households in the three size-of-place categories. However, in other rural areas, slightly greater proportions of households reported shorter terms of residence, and smaller proportions reported very long terms of residence (sixteen years or longer). Specifically, 23.9 percent of household heads (4.3 million) had lived in the household for one year or less, and 44.4 percent (8.0 million) had lived in the household for two through ten years. For large and small rural communities both, about 21 percent had lived in the household for one year or less, and about 41 percent had lived in the household for two through ten years. (These proportions amounted to a length of residence of one year or less for 498,000 household heads in large communities and 321,000 in small communities, and to a length of residence of two through ten years for 961,000 household heads in large communities and 615,000 in small communities.) Further, only 22.7 percent of households in other rural areas (4.1 million) reported terms of residence of sixteen years or more, compared to 29.7 percent in large rural communities (705,000) and 29.3 percent in small rural communities (442,000). (Almost equal proportions of households in each size-of-place category—approximately 9 percent—reported terms of residence of eleven through fifteen years.)

The median length of residence of the household head was 5.2 years for other rural areas, 6.6 years for large rural communities, and 5.8 years for small rural communities.

SIZE-OF-PLACE VARIATION IN ATTRIBUTES OF HOUSEHOLD HEADS

Size-of-place variation in sex of head

Unlike the regional and SMSA/nonSMSA comparisons, the size-of-place comparison showed marked differences in the number of rural households with female heads. Because so much of the rural population is located in other rural areas, the national estimate of 18.7 percent of households with female heads closely approximated the proportion in other rural areas (17.7 percent). However, in large rural communities, 22.3 percent of households had female heads, and in small rural communities the proportion of households with female heads was as high as 25.3 percent.

Overall, the number of households with female heads was higher in the NSA than in the 1970 census. The differences found in the size-of-place comparison would seem to indicate an uneven pattern of social change, with households in other rural areas maintaining more traditional family roles. The findings may also reflect social change in a more specific way; that is, there may be a disproportionately small number of single-parent households, which usually have female heads, in other rural areas.

Size-of-place variation in ethnicity of head

The size-of-place breakdown of data on the ethnicity of the head of the household showed notable variation from the national estimates of 91.3 percent white, 5.9 percent black, 1.4 percent Hispanic, and 1.3 percent other ethnic groups. Households in other rural areas showed proportions almost identical to the national estimates. Rural communities showed somewhat different patterns. In large rural communities, heads of households were 89.3 percent white, 7.6 percent black, 2.1 percent Hispanic, and 1.1 percent other ethnic groups. In small rural communities, the proportions were again different: 94.3 percent white, 2.1 percent black, 3.1 percent Hispanic, and 0.5 percent other ethnic groups.

Thus, proportionately, there were far fewer households with heads designated as black in small rural communities than in large rural communities or other rural areas. Also, other rural areas had fewer households with heads designated as Hispanic than did either large or small rural communities. Altogether, nonwhite household heads numbered 254,000 in large communities (10.8 percent), 85,000 in small communities (5.7 percent), and 1.6 million in other rural areas (8.6 percent).

Size-of-place variation in age of head

National NSA data indicated a marked change in the rural population since 1970 towards younger heads of household. The change in median age is one indication of the shift. According to the 1970 census, the median age for heads of rural households was 49.0 years, while the NSA estimate was 44.0 years in 1978. Whatever changes have taken place, however, they were not reflected equally in the age make-up of the three size-of-place categories in the NSA (see Table III-36). The biggest differences were that other rural areas had the highest proportion of household heads who were 35 to 44 years old, and the lowest proportion of household heads who were 65 or older. These two differences were primarily responsible for the difference in median ages: 49.0 years for large rural communities, 51.2 years for small rural communities, and 43.0 years for other rural areas. Largely responsible for the low median age in other rural areas was the small proportion of household heads who were 65 or older. In other rural areas, the proportion who were 65 or older was 18.6 percent (3.4 million household heads), compared to 28.0 percent in large rural communities (663,000) and 30.8 percent in small rural communities (465,000).

Size-of-place variation in years of schooling of head

Other rural areas were marked by higher educational levels than existed in large or small rural communities. In particular, 65.8 percent of household heads in other rural areas had at least twelve years of schooling, compared to 63.1 percent in small rural communities and 56.7 percent in large rural communities. Stated differently, in other rural areas, 34.0 percent of household heads had less than twelve years of schooling, compared to 36.9 percent in small communities and 43.0

Table III-36
Size-of-Place Variation in Age of Household Head

	Number and Percent of Households		
Age	Large Rural Communities	Small Rural Communities	Other Rural Areas
18 - 24	220,000 9.3%	138,000 9.2%	1,060,000 5.9%
25 - 34	445,000 18.8%	359,000 23.8%	4,262,000 23.6%
35 - 44	371,000 15.7%	165,000 10.9%	4,125,000 22.8%
45 - 64	671,000 28.3%	381,000 25.3%	5,263,000 29.1%
65 or older	663,000 28.0%	465,000 30.8%	3,361,000 18.6%
Unknown	0 0.0%	0 0.0%	23,000 0.1%
Total	2,369,000 100.1%	1,509,000 100.0%	18,095,000 100.1%

Each figure in the table is rounded independently; numbers and percentages may not equal rounded totals.

percent in large communities. These proportions translate to large numbers of rural household heads with less than twelve years of education, a level generally considered necessary for successful competition in the job market: there were 6.2 million such household heads in other rural areas, 557,000 in small communities, and 1.0 million in large communities.

At the lowest part of the spectrum, 20.8 percent of household heads in other rural areas (3.7 million) had eight years or less of schooling, compared to 24.4 percent in large communities (575,000) and 23.8 percent in small communities (359,000). In contrast, in other rural areas, 18.5 percent of household heads (3.3 million) had at least four years of college, compared to 13.0 percent in large communities (308,000) and 14.0 percent in small communities (211,000).

Size-of-place variation in employment status of head

Important differences in employment status could be seen among the three size-of-place categories, differences which paralleled those in age and income. In other rural areas, 67.3 percent of household heads (12.2 million) were working full time, and 19.4 percent (3.5 million) were retired. These proportions were very different for the other two categories. In large rural communities, 60.2 percent of household heads were working full time (1.4 million) and 27.6 percent were retired (653,000). In small rural communities, only 57.3 percent were working full time (864,000) and 31.5 percent were retired (475,000). The proportions of household heads who were working part time, keeping house, unemployed, and going to school were in close agreement with national estimates.

Size-of-place variation in occupation of head

Except for the fact that a much greater proportion of household heads in other rural areas were farmers or farm managers (8.1 percent, compared to 2.2 percent in large rural communities and 4.4 percent in small rural communities), occupational differences among the three size-of-place categories were not striking (see Table III-37).

In other rural areas, the proportion of household heads classified as professional and technical workers was slightly higher than elsewhere, and the proportions in clerical and service jobs and working as transportation and equipment operatives were lower.

Large rural communities showed a smaller proportion of craftsmen and the greatest proportion of people in service jobs among the three size-of-place categories. Large rural communities also had more laborers and transportation equipment operatives. Small rural communities had the greatest proportion of clerical workers and the smallest proportion of managers and administrators.

If some occupation categories are combined to reflect the probable status of the jobs comprising them, the two top categories—managers and administrators, and professional and technical workers—included 33.7 percent of household heads in other rural areas and 32.4 percent in large rural communities, but only 28.3 percent in small rural communities. Similarly, fewer household heads in other rural areas had jobs as service workers, farm laborers and foremen, and other types of laborers. Combined, these categories included 17.7 percent of household heads in large rural communities, 13.8 percent in small rural communities, and 10.8 percent in other rural areas.

Summary, Size-of-place variation in demographic profile

Distinctive demographic profiles emerged for households located in the three different size-of-place categories. Other rural areas, which included 18.1 million of the 22.0 million rural households in the United States, were characterized by higher incomes, higher employment, a smaller proportion of household heads who were retired, and a larger family size. Relatively few household heads were female. Household heads were, on the average, younger and better educated;

Table III-37
Size-of-Place Variation in Occupation of Household Head

	Number and Percent of Households		
Occupation	Large Rural Communities	Small Rural Communities	Other Rural Areas
Professonal, technical, and kindred	217,000 13.6%	125,000 13.8%	2,144,000 16.1%
Managers, administrators, except farm	299,000 18.8%	132,000 14.5%	2,346,000 17.6%
Sales workers	41,000 2.6%	49,000 5.4%	648,000 4.9%
Clerical and kindred	108,000 6.8%	86,000 9.5%	591,000 4.4%
Craftsmen and kindred	255,000 16.0%	201,000 22.1%	2,737,000 20.6%
Operatives, except transportation	195,000 12.3%	72,000 7.9%	1,594,000 12.0%
Transportation and equipment operatives	159,000 10.0%	78,000 8.6%	720,000 5.4%
Laborers, except farm	114,000 7.2%	38,000 4.2%	597,000 4.5%
Farmers and farm managers	35,000 2.2%	40,000 4.4%	1,073,000 8.1%
Farm laborers and foremen	24,000 1.5%	14,000 1.6%	171,000 1.3%
Service, except private household	143,000 9.0%	72,000 8.0%	664,000 5.0%
Private household	0 0.0%	0 0.0%	9,000 0.1%
*Total	1,590,000 100.0%	907,000 100.0%	13,294,000 100.0%

*Table includes only those household heads who were employed full time or part time.

Each figure in the table is rounded independently; numbers and percentages may not equal rounded totals.

a smaller proportion of them were employed in service jobs or as laborers of various kinds. Also, on the average, their length of residence in the household was shorter.

The 2.4 million households located in large rural communities had the lowest proportion of household heads with twelve or more years of education, the highest proportion of nonwhite household heads, and the highest proportion of heads employed in service jobs or as laborers. Also, large rural communities had the lowest rate of home ownership but at the same time the longest average length of residence.

Small rural communities, where 1.5 million households were located, had the lowest employment rate and the highest proportion of household heads in retirement. They also had the highest proportion of female heads of households, the smallest proportion of nonwhite household heads, and the lowest proportion of heads employed as managers and administrators or as professional and technical workers.

USES OF WATER IN RURAL US HOUSEHOLDS

The uses of the major water supply constituted another kind of basic descriptive information about rural households—an extension, as it were, of the demographic profile just presented. For instance, regardless of what type of water supply a household had, its uses of water were likely to be a function of many demographic characteristics in addition to regional climatic differences. For example, the variety of uses might be influenced by whether or not a household was engaged in farming. Also, higher socioeconomic status might be an influence towards greater use of water for recreational and ornamental purposes. In any event, a greater variety of uses probably would cause a greater quantity of water to be used, perhaps resulting in a strain on some household supplies. For many relationships explored in the NSA, then, a tabulation of rural households' indoor and outdoor uses of water constituted basic descriptive information.

TYPES OF WATER USES IN RURAL HOUSEHOLDS

Drinking water is only a small portion of all the water typically used in a household, but almost all rural households (about 97 percent) used their major water supply for drinking (see Chapter IV for details about the 3 percent that did not). In fact, at least 90 percent of all US rural households used the major household water supply for six indoor purposes: drinking, cooking, bathing, flushing toilets, washing dishes, and washing clothes. Only 7.3 percent of households reported a seventh use with any frequency—cooling the house by means of an evaporative cooler.

Concerning outdoor uses, 80.6 percent of US rural households used the major household water supply for periodic cleaning—washing windows, cars, and so forth. The second most common outdoor use was watering lawns and gardens, mentioned at 66.2 percent of rural households. Other significant outdoor uses included watering of livestock (12.0 percent of rural households) and recreational uses (7.6 percent). On the other hand, 15.1 percent of rural households did not use the major household water supply for any outdoor purpose. Proportions of rural households reporting the various outdoor uses are given in Table III-38, along with the regional variation in these uses.

SUBNATIONAL VARIATION IN WATER USES

Only one type of indoor use—cooling the house with an evaporative cooler—showed significant variation from region to region. At the national level, 7.3 percent of all rural households used water for cooling the house, but in fact this use was reported almost exclusively in the West (29.1 percent of rural households in that region). In a related finding, evaporative coolers were reported much more

Table III-38

Outdoor Uses of Major Water Supplies at Rural Households: US and Regional Variation

	Percent of Households				
Type of Use	Nation	Northeast	North Central	South	West
Periodic cleaning	80.6	83.0	78.6	78.3	89.8
Watering lawn or garden	66.2	66.4	67.2	58.1	90.9
Watering livestock	12.0	6.3	16.8	10.3	14.4
Recreational	7.6	12.8	5.5	5.1	13.7
Ornamental	3.6	2.7	4.3	1.9	8.8
Farm pond	0.6	0.6	0.6	0.4	1.3
Greenhouse	0.7	0.2	0.5	0.4	2.8
Irrigation	0.9	0.6	0.9	0.5	2.3
Other outside use	0.0	0.2	0.5	0.4	2.8
No outside use	15.1	13.4	17.6	18.5	3.7
Total Households	21,974,000	3,693,000	6,213,000	9,291,000	2,777,000

frequently in the West; see the following section, "Water-using fixtures and devices." Other subnational comparisons showed little substantive variation in indoor uses of the major household water supply, though other rural areas had a smaller proportion of households using water to flush toilets (95.6 percent) than did large rural communities (100 percent) or small rural communities (98.0 percent). Variation in this particular use coincided with regional variation in the presence of flush toilets, also reported in the following section of this chapter.

Three types of indoor uses—flushing toilets, washing clothes, and cooling the house—showed some variation according to the size of system serving the household. In particular, the larger the system size, the more households that used water for flushing and for cooling the house. For example, 92.4 percent of rural households served by individual systems used their major household supply for flushing, compared to 97.0 percent of those served by intermediate systems and 99.1 percent of those served by community systems. Although reported much less frequently overall, the major household supply was used for cooling the house most frequently by households served by community systems (10.5 percent) and least frequently by those served by individual systems (3.5 percent). As to washing clothes, similar proportions of households served by individual and community systems reported this indoor use (89.1 percent and 92.4 percent, respectively); among households served by intermediate systems, the proportion was 84.5 percent.

As expected, outdoor uses showed more regional variation than indoor uses (see Table III-38 for regional variation in outdoor uses). A disproportionately high number of households in the West reported a variety of outdoor uses; prominent ones in the West were periodic outdoor cleaning, the watering of lawns and gardens, the watering of livestock, and recreational use. Further, the West had the lowest proportion of households reporting no outdoor uses of the major household water supply. The greater variety of outdoor uses clearly indicated a much greater demand for water among households in the West.

As to differences in outdoor uses between households located inside and outside of SMSAs, only two outdoor uses showed appreciable variation. Watering lawns and gardens was more common among SMSA households (74.1 percent) than among nonSMSA households (62.7 percent). Water was put to recreational use by 13.0 percent of SMSA households, but by only 5.0 percent of nonSMSA households.

Only one outdoor use of the major household water supply showed appreciable variation according to the location of households in large rural communities, small rural communities, or other rural areas (see Table III-39). Consistent with the fact that other rural areas had the greatest proportion of households owning or leasing farms, a larger proportion of households in other rural areas used the major household water supply for watering livestock—14.9 percent, compared to 0.9 percent in large rural communities and 5.1 percent in small rural communities.

The size-of-system comparison showed the greatest variation in outdoor uses. In particular, the two most prominent outdoor uses of water—periodic cleaning, and watering of lawns or gardens—were reported most often among households served by community systems and least often among those served by intermediate systems (see Table III-40). In fact, the proportions of households that used the major water supply for watering lawns and gardens differed by more than 17 percent.

Other interesting patterns were revealed by the water use data. Not unexpectedly, very few households served by community systems (about 3 percent) used the major supply for watering livestock; in contrast, nearly 22 percent of households using individual systems did. Also, a larger proportion of households served by intermediate systems reported no outdoor uses of the major household water supply (20.5 percent, compared to 16.8 percent of households served by individual systems and 12.7 percent of those served by community systems).

Table III-39

Size-of-Place Variation in Outdoor Uses of the Major Household Water Supply

Use	Percent of Households		
	Large Rural Communities	Small Rural Communities	Other Rural Areas
Periodic cleaning	82.3	82.2	81.0
Watering lawn or garden	67.0	72.2	64.9
Watering livestock	0.9	5.1	14.9
Recreational	6.7	3.3	6.5
Ornamental	2.2	3.0	3.0
Farm pond	1.0	0.0	0.8
Greenhouse	0.9	0.0	1.0
Irrigation	0.6	0.0	1.1
Other outdoor use	0.0	0.0	0.2
No outdoor use	11.0	13.1	14.4
Total Households	2,369,000	1,509,000	18,095,000

Table III-40

Size-of-System Variation in Outdoor Uses of the Major Household Water Supply

Use	Percent of Households Individual System	 Intermediate System	 Community System
Periodic cleaning	80.1	74.9	82.4
Watering lawn or garden	61.9	54.6	72.1
Watering livestock	21.8	17.1	3.1
Recreational	5.5	7.1	9.4
Ornamental	2.7	1.6	4.7
Farm pond	1.1	1.0	0.1
Greenhouse	1.0	0.9	0.4
Irrigation	1.6	1.5	0.2
Other outdoor use	0.4	0.0	0.0
No outdoor use	16.8	20.5	12.7
Total Households	8,765,000	2,228,000	10,981,000

SUMMARY, USES OF WATER

Almost all rural households (97 percent) used their major water supply for drinking. Five other indoor uses of water were reported by at least 90 percent of all rural households: cooking, bathing, flushing toilets, washing clothes, and washing dishes. Other indoor uses were uncommon. The most significant outdoor uses were periodic cleaning (windows, cars, and so forth), reported by 80.6 percent of rural households; watering lawns and gardens (66.2 percent); watering of livestock (12.0 percent); and recreational uses (7.6 percent).

Indoor uses showed little regional variation, except that using water to cool the house (by means of an evaporative cooler) was reported almost exclusively in the West (29.1 percent of rural households in that region). Likewise, in the SMSA/nonSMSA and size-of-place comparisons, indoor uses showed little variation, though using water to flush toilets was reported by slightly fewer households in other rural areas than elsewhere. Also, this use was reported less frequently among households using individual water supply systems (92.4 percent) than among households served by intermediate or community systems. Using water to cool the house was reported most frequently by households served by community systems. Washing clothes was a reported use least frequently among households served by intermediate systems.

Outdoor uses showed substantial regional variation, with households in the West reporting a variety of outdoor uses much more frequently than households in other regions. In the SMSA/nonSMSA comparison, SMSA households reported two uses much more frequently than nonSMSA households—for watering lawns and gardens, and for recreational purposes. In the size-of-place comparison, only one outdoor use showed appreciable variation—watering livestock, which was reported almost exclusively by households in other rural areas. Two uses—watering lawns and gardens, and periodic outdoor cleaning—were reported most often by households served by community systems and least often by households served by intermediate systems. Having no outdoor uses for the major water supply also was most common among households served by intermediate systems.

WATER-USING FIXTURES AND DEVICES

TYPES OF FIXTURES AND DEVICES IN RURAL HOUSEHOLDS

A profile of rural households would not be complete without an assessment of physical features of housing which are indicative of normal water usage at a household, the general state of the household water supply, and ways in which the household may be limited in its use of water. Specifically, respondents in the NSA survey were asked to report on the presence of household items ranging from bathtubs to humidifiers. Some of these physical features are used in the census as standard indicators of housing quality, such as the presence of complete plumbing facilities.

Using the census definition, more than 90 percent of rural households in each of the four regions were equipped with complete plumbing facilities. That is, they contained piped hot and cold water, a flush toilet, and either a bathtub or shower. In the West, 98.8 percent of households were so equipped. In the North Central, the proportion was 96.6 percent; in the Northeast, it was 94.5 percent. The South had the lowest proportion of households with complete plumbing facilities—91.5 percent; 8.4 percent of the households there (780,000) lacked some or all of these facilities. When households were compared according to their location inside or outside SMSAs, the NSA found that a greater proportion of nonSMSA households lacked some plumbing facility—7.3 percent, compared to only 2.2 percent of households located inside SMSAs. These findings were in close agreement with 1970 census data and the 1976 Annual Housing Survey; see Appendix B for details. NSA data for size-of-place differences showed that 6.2 percent of households in other rural areas lacked some plumbing facility, compared to 4.6 percent in small rural communities and only 1.5 percent in large rural communities. (Comparable size-of-place data were not available from the 1970 census or 1976 Annual Housing Survey.)

The completeness of plumbing facilities, though a standard indicator of housing quality, provided only a rough indication of certain aspects of a household's water supply. For understanding overall patterns of household water consumption, it was necessary for the NSA to find out how many rural households had various other kinds of water-using equipment besides bathroom fixtures. Consequently, the NSA collected data on an exhaustive list of fixtures and devices. It was expected that the number of water-using fixtures and devices present at a household would have an effect on the quantity of water consumed, and this relationship is explored in Chapter XI. Here, the groundwork for that exploration is laid by first setting forth the proportions of rural households having various devices attached to their water supplies or having direct access to the devices by a sharing arrangement. Later in this section, there is a tabulation of the total number of water-using devices present in the average rural household.

Among the more common fixtures and devices present in rural households were bathtubs, showers, bathroom sinks, kitchen sinks, flush toilets, water heaters, and washing machines. Less common items were dishwashers, humidifiers, and evaporative (swamp) coolers. To be counted, bathtubs, showers, sinks, and flush toilets had to be operational and attached to a water supply. Clothes washers and dishwashers designated any mechanical devices for those respective purposes. Water heaters included free-standing hot water heaters and furnace coils which provided the household with piped hot water. (Furnace coils are water-heating devices built into certain furnaces; in the NSA, they were found only in the Northeast.) The term "evaporative cooler" referred to a device commonly used in arid climates for cooling houses.

As seen in Table III-41, 95.1 percent or more of rural US households (20.9 million) had at least one kitchen sink, bathing facility, toilet, bathroom sink, or

Table III-41

Water-Using Fixtures and Devices in Use at Rural Households

Fixture or Device	Nation Number of Households	 Percent of Households
Kitchen sink	21,556,000	98.1
Bathing facility (shower or bathtub)	21,183,000	96.4
Bathtub	20,238,000	92.1
Shower	17,403,000	79.2
Toilet	21,051,000	95.8
Bathroom sink	21,029,000	95.7
Water heater	20,897,000	95.1
Washing machine	18,304,000	83.3
Dishwasher	8,284,000	37.7
Humidifier	2,923,000	13.3
Evaporative (swamp) cooler	1,143,000	5.2
Other facilities	703,000	3.2
*Total Households	21,974,000	

*Table reports households having at least one fixture or device, or having access to shared facilities of each type.

water heater, or else shared access to these facilities. Bathing facilities consisted of a bathtub in 92.1 percent of rural households and a shower in 79.2 percent. As noted at the beginning of this section, more than 90 percent also had complete plumbing and bathroom facilities. Washing machines also were common in rural America; 83.3 percent of rural households either had a washing machine or shared one.

The other devices or fixtures were far less prevalent. Dishwashers were present at 37.7 percent of all rural households, humidifiers at 13.3 percent, and evaporative coolers and miscellaneous other facilities at about 5 percent or fewer. Shared facilities are not discussed separately because they were so infrequent, having been reported in 1.0 percent or less of households across the nation. Washing machines were the most commonly shared device, reported twice as often as any other shared water-using facility.

REGIONAL VARIATION IN WATER-USING FIXTURES AND DEVICES

There were appreciable differences among regions in the prevalence of various water-using fixtures (see Table III-42). In particular, proportionately fewer households in the South had the five most significant items—a kitchen sink, bathing facility, toilet, bathroom sink, and water heater. One unexpected finding was the difference in relative frequency of households with water heaters. In the South, only 92.7 percent of rural households were equipped with water heaters, compared to 96.5 percent in the Northeast, 97.4 percent in the North Central, and 99.0 percent in the West. The greatest regional variation was apparent in the use of humidifiers and evaporative coolers, and reflected regional climatic conditions. Humidifiers were far more common in the North Central than anywhere else. Specifically, 28.9 percent of households in the North Central had humidifiers, compared to 16.2 percent in the Northeast, 5.2 percent in the West, and 4.1 percent in the South. By contrast, evaporative coolers were reported in 29.3

Table III-42

Regional Variation in Water-Using Fixtures and Devices in Use at Rural Households

Fixture or Device	Northeast	North Central	South	West
	Number and Percent of Households			
Kitchen sink	3,682,000 99.7%	6,138,000 98.8%	8,966,000 96.5%	2,760,000 99.4%
Bathing facility (shower or bathtub)	3,638,000 98.5%	6,095,000 98.1%	8,715,000 93.8%	2,749,000 99.0%
Bathtub	3,475,000 94.1%	5,809,000 93.5%	8,371,000 90.1%	2,588,000 93.2%
Shower	3,213,000 87.0%	4,785,000 77.0%	7,089,000 76.3%	2,328,000 83.8%
Toilet	3,586,000 97.1%	6,039,000 97.2%	8,687,000 93.5%	2,749,000 99.0%
Bathroom sink	3,608,000 97.7%	6,045,000 97.3%	8,650,000 93.1%	2,727,000 98.2%
Water heater	3,564,000 96.5%	6,051,000 97.4%	8,613,000 92.7%	2,749,000 99.0%
Washing machine	3,128,000 84.7%	5,138,000 82.7%	7,758,000 83.5%	2,288,000 82.4%
Dishwasher	1,525,000 41.3%	2,181,000 35.1%	3,224,000 34.7%	1,369,000 49.3%
Humidifier	598,000 16.2%	1,796,000 28.9%	381,000 4.1%	144,000 5.2%
Evaporative (swamp) cooler	26,000 0.7%	68,000 1.1%	223,000 2.4%	814,000 29.3%
Other facilities	137,000 3.7%	149,000 2.4%	195,000 2.1%	194,000 7.0%
*Total Households	3,693,000	6,213,000	9,291,000	2,777,000

*Table reports households having at least one fixture or device, or having access to shared facilities of each type.

percent of rural households in the West, 2.4 percent in the South, and 1.1 percent or less in the North Central and Northeast.

Regional differences also were noted in the proportions of households with showers and dishwashers. Approximately 77 percent of households in the North Central and South had showers, compared to 83.8 percent in the West and 87.0 percent in the Northeast. Similarly, dishwashers were less common in the North Central and South (about 35 percent of households), while they were present in 49.3 percent of households in the West and in 41.3 percent in the Northeast.

SMSA/NonSMSA VARIATION IN WATER-USING FIXTURES AND DEVICES

Besides regional differences, there were also striking differences in the prevalence of various water-using fixtures and devices between households within SMSAs and those outside of them (see Table III-43). Except for evaporative coolers, each item was less common among nonSMSA households.

There are various possible explanations for this. Rural communities in SMSAs are generally within the periphery of suburbs. There may be a greater orientation toward labor- and time-saving devices in suburbs which could partly explain the greater incidence of dishwashers (56.9 percent versus 28.7 percent), showers (88.2 percent versus 75.0 percent), and washing machines (88.1 percent versus 81.1 percent).[3] A more likely explanation, however, is the simple fact that income was higher for SMSA households than for nonSMSA households, as discussed earlier in this chapter. Another possible explanation may lie in the type of water supply system serving the household. Dishwashers and showers generally require between 40 and 60 pounds of pressure per square inch to operate efficiently.[4] It may be that community water systems, which are more prevalent within SMSAs, are better able to provide the pressure required for these devices.

Table III-43

SMSA/NonSMSA Variation in Water-Using Fixtures and Devices

	Number and Percent of Households	
Fixture or Device	SMSA	NonSMSA
Kitchen sink	7,019,000 99.7%	14,531,000 97.3%
Bathing facility (shower or bathtub)	6,984,000 99.2%	14,202,000 95.1%
Bathtub	6,808,000 96.7%	13,441,000 90.0%
Shower	6,209,000 88.2%	11,200,000 75.0%
Toilet	6,991,000 99.3%	14,068,000 94.2%
Bathroom sink	6,948,000 98.7%	14,083,000 94.3%
Water heater	6,892,000 97.9%	14,083,000 94.3%
Washing machine	6,202,000 88.1%	12,111,000 81.1%
Dishwasher	4,006,000 56.9%	4,286,000 28.7%
Humidifier	1,028,000 14.6%	1,897,000 12.7%
Evaporative (swamp) cooler	296,000 4.2%	836,000 5.6%
Other facilities	239,000 3.4%	448,000 3.0%
*Total Households	7,040,000	14,934,000

*Table reports households having at least one fixture or device, or having access to shared facilities of each type.

SIZE-OF-PLACE VARIATION IN WATER-USING FIXTURES AND DEVICES

As seen in Table III-44, at least 95 percent of households in each category had at least one kitchen sink, bathing facility, flush toilet, bathroom sink, and water heater, or else shared access to them. Nonetheless, slight differences were apparent, and indicated that households in large rural communities were best equipped while other rural areas had the lowest proportions of households having each item.

Interestingly, a different pattern emerged with regard to washing machines and dishwashers. These devices were reported most often in other rural areas. For example, dishwashers were reported in 39.9 percent of households in other rural areas, compared to 29.8 percent in large rural communities and 24.0 percent in small rural communities. Although washing machines also were present most often at households in other rural areas, the proportional differences were smaller. One explanation for the larger proportion of washing machines in other rural areas might be the inaccessibility of neighborhood laundromats, but dishwashers—which are primarily convenience appliances—were far more prevalent than expected.

On the other hand, humidifiers were used by a much smaller proportion of households in other rural areas than in large or small rural communities.

SIZE-OF-SYSTEM VARIATION IN WATER-USING FIXTURES AND DEVICES

NSA data showed that, with regard to the five most important fixtures and devices (kitchen sink, bathing facility, flush toilet, bathroom sink, and water heater), the lowest proportions of each were found among households served by individual water systems (see Table III-45). For households served by intermediate and community systems, the proportions were higher and about equal. Kitchen sinks were by far the most prevalent fixtures, and were present in households that lacked other important facilities. Specifically, 96.1 percent of households served by individual systems were equipped with kitchen sinks, compared to at least 99

Table III-44

Size-of-Place Variation in Water-Using Fixtures and Devices

	Number and Percent of Households		
Fixture or Device	Large Rural Communities	Small Rural Communities	Other Rural Areas
Kitchen sink	2,369,000 100.0%	1,479,000 98.0%	17,697,000 97.8%
Bathing facility (shower or bathtub)	2,369,000 100.0%	1,471,000 97.5%	17,353,000 95.9%
Bathtub	2,194,000 92.6%	1,372,000 90.9%	16,684,000 92.2%
Shower	1,729,000 73.0%	1,083,000 71.8%	14,603,000 80.7%
Toilet	2,357,000 99.5%	1,468,000 97.3%	17,226,000 95.2%
Bathroom sink	2,333,000 98.5%	1,455,000 96.4%	17,245,000 95.3%
Water heater	2,369,000 100.0%	1,438,000 95.3%	17,172,000 94.9%
Washing machine	1,872,000 79.0%	1,242,000 82.3%	15,200,000 84.0%
Dishwasher	706,000 29.8%	362,000 24.0%	7,220,000 39.9%
Humidifier	467,000 19.7%	305,000 20.2%	2,153,000 11.9%
Evaporative (swamp) cooler	121,000 5.1%	112,000 7.4%	905,000 5.0%
Other facilities	107,000 4.5%	47,000 3.1%	561,000 3.1%
*Total Households	2,369,000	1,509,000	18,095,000

*Table reports households having at least one fixture or device, or having access to shared facilities of each type.

Table III-45

Size-of-System Variation in Water-Using Fixtures and Devices

	Number and Percent of Households		
Fixture or Device	Individual System	Intermediate System	Community System
Kitchen sink	8,423,000 96.1%	2,212,000 99.3%	10,915,000 99.4%
Bathing facility (shower or bathtub)	8,143,000 92.9%	2,166,000 97.2%	10,882,000 99.1%
Bathtub	7,775,000 88.7%	2,007,000 90.1%	10,465,000 95.3%
Shower	6,512,000 74.3%	1,749,000 78.5%	9,158,000 83.4%
Toilet	8,029,000 91.6%	2,168,000 97.3%	10,860,000 98.9%
Bathroom sink	8,073,000 92.1%	2,150,000 96.5%	10,805,000 98.4%
Water heater	8,055,000 91.9%	2,177,000 97.7%	10,750,000 97.9%
Washing machine	7,424,000 84.7%	1,622,000 72.8%	9,268,000 84.4%
Dishwasher	2,971,000 33.9%	524,000 23.5%	4,799,000 43.7%
Humidifier	1,499,000 17.1%	180,000 8.1%	1,252,000 11.4%
Evaporative (swamp) cooler	219,000 2.5%	100,000 4.5%	813,000 7.4%
Other facilities	272,000 3.1%	71,000 3.2%	351,000 3.2%
*Total Households	8,765,000	2,228,000	10,981,000

*Table reports households having at least one fixture or device, or having access to shared facilities of each type.

percent of households served by larger systems. Similarly, 92.9 percent of households using individual systems had some bathing facility (either a bathtub or shower), compared to 97.2 percent served by intermediate systems and 99.1 percent served by community systems. Toilets and bathroom sinks were present at about 92 percent of individual-system households, at 96 percent or more of intermediate-system households, and at 98 percent or more of community-system households. Finally, roughly 92 percent of households using individual systems were equipped with water heaters, compared to about 98 percent of those served by larger systems.

Interestingly, a different pattern emerged with regard to washing machines and dishwashers. Washing machines were present in about 85 percent of households served by either individual or community systems, but in only 72.8 percent of households served by intermediate systems. Dishwashers were present in 43.7 percent of households served by community systems, 33.9 percent of households served by individual systems, and 23.5 percent of households served by intermediate systems. That is, proportionately fewer households served by intermediate systems had washing machines and dishwashers.

RURAL HOUSEHOLDS LACKING ESSENTIAL WATER-USING FIXTURES AND DEVICES

Another way of presenting the preceding data is from the perspective of households that lacked the fixtures and devices usually associated with proper sanitary practices and cleanliness. Several of the national findings become more apparent when examined this way. For instance, as Table III-46 indicates, 4.5 percent of rural households (989,000) had no water heater, and so had no piped hot water. Likewise, a bathtub was lacking in about 8 percent of all rural households (1.7 million), while more than one-fifth of rural households had no shower. Both bathtub and shower were missing in 3.6 percent of rural households; these 791,000

Table III-46

Rural Households Lacking Essential Water-Using Fixtures and Devices: US and Regional Variation

Absent Fixture or Device	Number and Percent of Households				
	Nation	Northeast	North Central	South	West
Kitchen sink	418,000 1.9%	11,000 0.3%	75,000 1.2%	325,000 3.5%	17,000 0.6%
Bathing facility (shower and bathtub both absent)	791,000 3.6%	55,000 1.5%	118,000 1.9%	576,000 6.2%	28,000 1.0%
Bathtub	1,736,000 7.9%	218,000 5.9%	404,000 6.5%	920,000 9.9%	189,000 6.8%
Shower	4,571,000 20.8%	480,000 13.0%	1,429,000 23.0%	2,193,000 23.6%	450,000 16.2%
Toilet	923,000 4.2%	107,000 2.9%	174,000 2.8%	604,000 6.5%	28,000 1.0%
Bathroom sink	945,000 4.3%	85,000 2.3%	168,000 2.7%	641,000 6.9%	50,000 1.8%
Water heater	989,000 4.5%	129,000 3.5%	162,000 2.6%	678,000 7.3%	28,000 1.0%
*Total Households	21,974,000	3,693,000	6,213,000	9,291,000	2,777,000

*Table reports households lacking at least one fixture or device, or not having access to shared facilities of each type.

households had no normal bathing facilities. More than 4 percent (923,000 households) had no toilet and about the same proportion had no bathroom sink.

As to regional differences, rural households in the South showed a clear pattern of lacking more essential fixtures and devices than rural households in other regions (see Table III-46). Rural households in the West seemed, on the whole, to be best equipped, with only 1.0 percent lacking bathing facilities, water heaters, or toilets.

In the SMSA/nonSMSA comparison, a greater proportion of nonSMSA households were seen to lack each item of essential water-using equipment (see Table III-47). There was a difference of five percentage points in the proportions of households with flush toilets, and a difference of 4.1 percent in the proportions with some bathing facility (either bathtub or shower).

In general, households located in other rural areas lacked essential water-using equipment more often than households in small or large rural communities (see Table III-48). Households in large rural communities, on the other hand, almost never lacked these devices. In particular, 5.1 percent of households in other rural areas (slightly less than one million) had no piped hot water, while the NSA found no households in large communities that lacked hot water. Likewise, 4.8 percent of households in other rural areas lacked toilets, compared to 0.5 percent in large communities. Further, 4.1 percent of households in other rural areas had neither bathtub nor shower, but the NSA found no households in this situation in large communities.

As for differences related to the size of the supply system, households served by individual systems were most likely to be lacking some important water-using device (see Table III-49). About 7 to 8 percent of households served by individual systems lacked complete bathrooms—toilet, bathroom sink, and bathing facility—compared to about 1 or 2 percent of households served by community systems. Finally, 8.1 percent of households with individual water supply systems

Table III-47

SMSA/NonSMSA Variation in Rural Households Lacking Essential Water-Using Fixtures and Devices

	Number and Percent of Households	
Absent Fixture or Device	SMSA	NonSMSA
Kitchen sink	21,000 0.3%	403,000 2.7%
Bathing facility (shower and bathtub both absent)	56,000 0.8%	732,000 4.9%
Bathtub	232,000 3.3%	1,493,000 10.0%
Shower	831,000 11.8%	3,734,000 25.0%
Toilet	49,000 0.7%	866,000 5.8%
Bathroom sink	92,000 1.3%	851,000 5.7%
Water heater	148,000 2.1%	851,000 5.7%
*Total Households	7,040,000	14,934,000

*Table reports households lacking at least one fixture or device, or not having access to shared facilities of each type.

Table III-48

Size-of-Place Variation in Rural Households Lacking Essential Water-Using Fixtures and Devices

	Number and Percent of Households		
Absent Fixture or Device	Large Rural Communities	Small Rural Communities	Other Rural Areas
Kitchen sink	0	30,000	398,000
	0.0%	2.0%	2.2%
Bathing facility (shower and bathtub both absent)	0	38,000	742,000
	0.0%	2.5%	4.1%
Bathtub	175,000	137,000	1,411,000
	7.4%	9.1%	7.8%
Shower	640,000	426,000	3,492,000
	27.0%	28.2%	19.3%
Toilet	12,000	41,000	869,000
	0.5%	2.7%	4.8%
Bathroom sink	36,000	54,000	850,000
	1.5%	3.6%	4.7%
Water heater	0	71,000	923,000
	0.0%	4.7%	5.1%
*Total Households	2,369,000	1,509,000	18,095,000

*Table reports households lacking at least one fixture or device, or not having access to shared facilities of each type.

Table III-49

Size-of-System Variation in Rural Households Lacking Essential Water-Using Fixtures and Devices

Absent Fixture or Device	Number and Percent of Households Individual System	 Intermediate System	 Community System
Kitchen sink	342,000 3.9%	16,000 0.7%	66,000 0.6%
Bathing facility (shower and bathtub both absent)	622,000 7.1%	62,000 2.8%	99,000 0.9%
Bathtub	990,000 11.3%	221,000 9.9%	516,000 4.7%
Shower	2,253,000 25.7%	479,000 21.5%	1,823,000 16.6%
Toilet	736,000 8.4%	60,000 2.7%	121,000 1.1%
Bathroom sink	692,000 7.9%	78,000 3.5%	176,000 1.6%
Water heater	710,000 8.1%	51,000 2.3%	231,000 2.1%
*Total Households	8,765,000	2,228,000	10,981,000

*Table reports households lacking at least one fixture or device, or not having access to shared facilities of each type.

lacked piped hot water, compared to only about 2 percent of households served by intermediate or community systems.

TOTAL NUMBER OF WATER-USING FIXTURES AND DEVICES PER HOUSEHOLD

After examining the prevalence of common water-using fixtures and devices, the NSA tabulated the total number of such facilities in use at each household. This indicator was also expected to correspond to the level of household water consumption. Although water heaters are, strictly speaking, water storage devices, not water-using devices, they were included in the tabulation because piped hot water is usually a requirement for a variety of other devices. Also, shared facilities of various kinds were counted as single devices, since access to these facilities is sufficient for water to be used. Further, since showers and bathtubs often are combined into one unit, the tabulation counted the presence of any bathing facility, which could have been either a shower or bathtub, rather than counting both items separately.

The tabulation showed that rural households had an average of six water-using fixtures and devices, according to the statistical mean and median. The most typical household (shown by the statistical mode) had five devices, which presumably included a kitchen sink, a bathroom sink, a toilet, a bathtub or shower, and a water heater.

While some rural households lacked important water-using equipment, 40 percent had two or more toilets, 40 percent had two or more bathroom sinks, 20 percent had two or more showers, 12 percent had two or more bathtubs, and 9 percent had two or more kitchen sinks. Interestingly, some households had four or more of the various bathroom fixtures (744,000 households had four or more bathroom sinks; 151,000 had four or more toilets). Only 1 percent or less reported having more than one of the other kinds of fixtures and devices (water heater, washing machine, etc.).

Regional differences were again evident in the total number of water-using devices at rural households. Consistent with other NSA findings, households in the South generally had fewer such devices—the average number was 6.2; the median was 5.4. In contrast, for the West the average was 7.3 and the median 6.9. The Northeast and North Central fell between these extremes, the average number of devices in both regions being 6.7 and the median 6.1.

The SMSA/nonSMSA breakdown showed that nonSMSA households tended to have fewer water-using devices than SMSA households. The average number for households located outside of SMSAs was 6.2, compared to 7.4 for households within SMSAs.

Households in all three size-of-place categories had an average of six water-using devices, according to both the statistical mean and median. With respect to size-of-system differences, households served by intermediate systems had the fewest water-using devices (4.7), and households served by community systems had the most (5.8). The average household served by an individual supply system had 5.3 devices.

Summary, Water-using fixtures and devices

Most rural households across the United States were equipped with complete plumbing facilities, although the proportions varied from 98.8 percent in the West to 91.5 percent in the South. Households located outside SMSAs were more likely to be lacking some plumbing facility than households located inside SMSAs. Likewise, households in other rural areas were more likely to be lacking in some plumbing facility than were households in large or small rural communities.

As to specific fixtures and devices, there was a kitchen sink, bathing facility (either shower or tub), flush toilet, bathroom sink, and water heater in at least 95 percent of rural households across the US. Clothes washers were present in about 83 percent of rural households. Regional comparisons showed that a smaller proportion of rural households in the South were equipped with each of the five most significant items, though there was little variation in the proportions of rural households with clothes washers. Because of regional climatic differences, humidifiers were most common in the North Central and evaporative coolers were found almost exclusively in the West.

In the SMSA/nonSMSA comparison, a greater proportion of SMSA households had each water-using item tabulated in the NSA, except for evaporative coolers. In the size-of-place comparison, smaller proportions of households in other rural areas had each of the five most significant items, but larger proportions had clothes washers and dishwashers.

In the size-of-system comparison, households served by individual water supply systems were less likely to have each of the five most significant items, but households served by intermediate systems were much less likely than others to have clothes washers and dishwashers.

Examining the data the other way, the five essential items of water-using equipment were more likely to be missing in households in the South, households outside of SMSAs, and households located in other rural areas. Likewise, they were more likely to be missing from households served by individual water supply systems.

The typical rural household had five items of water-using equipment—presumably, a kitchen sink, bathroom sink, flush toilet, bathtub or shower, and water heater. Many, of course, had more than one of each of these, and many had other devices besides. There were fewer water-using fixtures and devices present in rural households in the South, and fewer outside of SMSAs. In the size-of-system comparison, households served by intermediate systems had the fewest water-using devices (an average of 4.7, compared to 5.3 among individual-system households and 5.8 among community-system households).

WASTEWATER SYSTEMS

Wastewater disposal, although generally regarded as separate from other elements of household water conditions, really represents the final stage in the process of household water supply. Characteristics of the wastewater disposal system—its type, general condition, and vulnerability to breakdowns—have numerous implications for household water use and public health. An inoperative wastewater disposal system restricts almost all household uses of water, and may lead to the contamination of the household's drinking water supply.

Because of the relationship between a household's water supply and its wastewater disposal system, the NSA included wastewater disposal systems in its study of general household water conditions. (The type of disposal system in use, and its reliability, could be expected to influence water use and perhaps even the quality of the household's water supply.) To evaluate reliability, the NSA compiled data on the number of disposal system breakdowns that had taken place during the year preceding the NSA. If any breakdowns had occurred, the reasons for the breakdowns were specified: did they occur because septic tanks, cesspools, or other disposal devices became inoperative; because household facilities such as pipes and toilets failed; because water was unavailable; because a public sewage disposal system was inoperative; or for some other reason? Breakdowns which lasted more than six hours were considered severe, and information about them was compiled separately.

TYPES OF WASTEWATER SYSTEMS IN RURAL US

The majority of rural households (14.1 million, or 64.3 percent) used either a septic tank, a cesspool, an aerobic tank, or some combination of these: a cesspool draining to surface water; a septic tank and cesspool; a septic tank and unattached drain field; or a dry well with or without a septic tank (see Table III-50). Public sewer systems constituted the next largest category of wastewater systems,

Table III-50

Wastewater Disposal Systems

Type of Wastewater System	Nation	
	Number of Households	Percent of Households
Public sewer system	6,217,000	28.3
Septic tank, cesspool, etc.	14,121,000	64.3
Direct discharges	1,337,000	6.1*
Unknown	297,000	1.4
Total	21,974,000	100.1

*Direct household discharges included wastewater that drained to a pond, lake, stream, or an on-premise body of water directly receiving the household's wastewater. Also included in this category are composting or biological disposal systems, privies, and drain fields, as well as wastewater that was simply dumped on the ground. No judgment is intended as to the appropriateness of these methods.

Each figure in the table is rounded independently; numbers and percentages may not equal rounded totals.

serving 6.2 million rural households (28.3 percent). (The term "public sewer system" included all such community facilities, regardless of ownership, although ownership generally was public.) Across the US, 1.3 million rural households (6.1 percent) discharged untreated wastewater directly into the environment in various ways—i.e., these households did not use any type of system that would subject their wastewater to a process of filtration and percolation.

The NSA data, compared to data compiled in 1970 and 1976, demonstrate an increase across the nation in the number of households served by public sewer systems and a corresponding decrease in the number of systems which discharge untreated wastewater directly into the environment (details are presented in Appendix B). At the same time, the prevalence of septic tanks and cesspools had also decreased since 1976. The reasons for these trends cannot be determined directly from NSA data, but there are at least two possible explanations. First, stricter enforcement of environmental regulations for households situated on or near bodies of water may have forced such households to upgrade their facilities to septic tanks or cesspools, or to use community treatment facilities. Second, although more households in this situation may have installed septic tanks or cesspools, the overall use of these devices may have declined because of increased availability of municipal sewage treatment plants. As some evidence for this possibility, the proportion of SMSA households served by public sewer systems increased by nearly 10 percent from 1976, whereas the proportion increased by only 1 percent for nonSMSA households (for details, see Appendix B).

REGIONAL VARIATION IN WASTEWATER SYSTEMS

Since 1976, the West showed the greatest relative increase in the number of households served by public sewer systems—9.9 percent (see Appendix B). At the time of the NSA, the West had a far greater proportion of households being served by public sewer systems than the other regions—42.7 percent (see Table III-51). In comparison, the proportion of households served by public systems was 28.0 percent in the South, 25.7 percent in the North Central, and 22.6 percent in the Northeast.

As to septic tanks, cesspools, and the like, the West had the smallest proportion (55.2 percent), and the Northeast had the highest proportion (74.7 percent). Compared to the other three regions, a far greater proportion of households in the South (almost 10 percent, or 901,000 households) discharged their wastewater directly into the environment. (That is, these households did not use any type of system that would subject their wastewater to a process of filtration by percolation.)

SMSA/NonSMSA VARIATION IN WASTEWATER SYSTEMS

Several differences were apparent when SMSA and nonSMSA households were compared with respect to sewage disposal systems (see Table III-52). About 39 percent of the households within SMSAs (2.8 million) had public sewer facilities, compared to only 23.1 percent of households outside of SMSAs (3.4 million). By the same token, 67.4 percent of nonSMSA households (10.1 million) used septic tanks or cesspools, compared to 57.6 percent of SMSA households (4.1 million). Another striking difference between SMSA and nonSMSA households was that 8.2 percent of nonSMSA households (1.2 million) discharged their wastewater directly into the environment, while only 1.6 percent of SMSA households did (about 100,000 households).

Table III-51

Regional Variation in Wastewater Systems

Type of Wastewater System	Number and Percent of Households: Northeast	North Central	South	West
Public sewer system	835,000 22.6%	1,597,000 25.7%	2,601,000 28.0%	1,186,000 42.7%
Septic tank, cesspool, etc.	2,759,000 74.7%	4,219,000 67.9%	5,621,000 60.5%	1,533,000 55.2%
Direct discharges	89,000 2.4%	298,000 4.8%	901,000 9.7%	42,000* 1.5%
Unknown	11,000 0.3%	99,000 1.6%	167,000 1.8%	17,000 0.6%
Total	3,693,000 100.0%	6,213,000 100.0%	9,291,000 100.0%	2,777,000 100.0%

*Direct household discharges included wastewater that drained to a pond, lake, stream, or an on-premise body of water directly receiving the household's wastewater. Also included in this category are composting or biological disposal systems, privies, and drain fields, as well as wastewater that was simply dumped on the ground. No judgment is intended as to the appropriateness of these methods.

Each figure in the table is rounded independently; numbers and percentages may not equal rounded totals.

Table III-52

SMSA/NonSMSA Variation in Wastewater Disposal Systems

Type of Wastewater System	Number and Percent of Households	
	SMSA	NonSMSA
Public sewer system	2,767,000 39.3%	3,450,000 23.1%
Septic tank, cesspool, etc.	4,055,000 57.6%	10,066,000 67.4%
Direct discharges	113,000 1.6%	1,225,000* 8.2%
Unknown	106,000 1.5%	194,000 1.3%
Total	7,040,000 100.0%	14,934,000 100.0%

*Direct household discharges included wastewater that drained to a pond, lake, stream, or an on-premise body of water directly receiving the household's wastewater. Also included in this category are composting or biological disposal systems, privies, and drain fields, as well as wastewater that was simply dumped on the ground. No judgment is intended as to the appropriateness of these methods.

Each figure in the table is rounded independently; numbers and percentages may not equal rounded totals.

The rapid increase of public sewer systems since 1976 (see Appendix B) was restricted almost completely to households within SMSAs. In 1976, 29.5 percent of all rural households within SMSAs were served by public systems; by 1978, the proportion had increased to 39.3 percent. Outside of SMSAs, very little change occurred in the proportion of public sewer systems (22.1 to 23.1 percent).

SIZE-OF-PLACE VARIATION IN WASTEWATER SYSTEMS

Between 1970 and 1978, the proportions of households using the various kinds of sewage disposal systems changed very little in large rural communities, though there was a slight increase in public sewer systems and a corresponding decrease in septic tanks and cesspools (for details, see Appendix B). Combining small rural communities and other rural areas (as done in the 1970 census), there was a rapid increase in the number of households using public sewer systems, rising from 10.9 percent in 1970 to 23.1 percent in 1978. Also, since 1970, the proportion of households in small communities and other rural areas that discharged wastes directly into the environment dropped from 14.5 percent to 8.0 percent.

At the time of the NSA, the patterns of wastewater disposal were quite different in large communities, small communities, and other rural areas (see Table III-53). As expected, wastewater disposal in other rural areas was accomplished predominantly by septic tanks and cesspools (about 71 percent of households had these systems). In large and small rural communities, there was less reliance on these systems. For example, in small rural communities, septic tanks, cesspools, and the like were used by 44.0 percent of households, and public sewer systems were used by 50.0 percent. In large communities, only 25.8 percent of households used septic tanks and cesspools, and 71.9 percent used public systems. The proportions of households discharging wastes directly into the environment also varied according to size of place, occurring at only 1.2 percent of households in large rural communities, but at 4.8 percent of households in small rural

Table III-53

Size-of-Place Variation in Wastewater Disposal Systems

Type of Wastewater System	Number and Percent of Households: Large Rural Communities	Small Rural Communities	Other Rural Areas
Public sewer system	1,703,000 71.9%	754,000 50.0%	3,764,000 20.8%
Septic tank, cesspool, etc.	611,000 25.8%	664,000 44.0%	12,829,000 70.9%
Direct discharges	28,000 1.2%	72,000 4.8%	1,104,000* 6.1%
Unknown	26,000 1.1%	17,000 1.1%	380,000 2.1%
Total	2,369,000 100.0%	1,509,000 99.9%	18,095,000 99.9%

*Direct household discharges included wastewater that drained to a pond, lake, stream, or an on-premise body of water directly receiving the household's wastewater. Also included in this category are composting or biological disposal systems, privies, and drain fields, as well as wastewater that was simply dumped on the ground. No judgment is intended as to the appropriateness of these methods.

Each figure in the table is rounded independently; numbers and percentages may not equal rounded totals.

communities and 6.1 percent of households in other rural areas (1.1 million households in other rural areas).

SIZE-OF-SYSTEM VARIATION IN WASTEWATER SYSTEMS

Differences in the types of wastewater systems used by rural households closely paralleled differences in the types of water supply systems serving them (see Table III-54). To a large extent, this variation is attributable to the fact that water and sewer districts are often established at the same time and that hook-up to a community water system usually precedes hook-up to a public sewer system. The findings reflected the close similarities between households served by individual and intermediate systems, and the very different characteristics of households served by community systems. Overwhelmingly, households served by the smaller systems used septic tanks or cesspools (about 87 percent of such households), while public sewer systems were used infrequently. In contrast, the majority of households served by community water systems used public sewer systems (54.3 percent), though 41.5 percent used septic tanks and cesspools. Sewage disposal consisted of direct discharges at 9.0 percent of households served by individual water systems, 6.4 percent of those served by intermediate systems, and 2.5 percent of those served by community water supply systems.

BREAKDOWNS IN RURAL WASTEWATER SYSTEMS

Frequency of wastewater system breakdowns in rural US

In the year prior to NSA data collection, 6.1 percent of all rural households (1.3 million) had problems with their wastewater disposal systems which made the systems completely inoperative. However, these breakdowns had been limited to one occurrence at 4.4 percent of all rural households (967,000) and to two occurrences at 0.7 percent (154,000). A very small proportion (35,000 households) had chronic breakdowns (from one to eight per month). At 941,000 households (4.3

Table III-54
Size-of-System Variation in Wastewater Disposal Systems

Type of Wastewater System	Number and Percent of Households Individual Water Supply System	 Intermediate Water Supply System	 Community Water Supply System
Public sewer system	193,000 2.2%	69,000 3.1%	5,963,000 54.3%
Septic tank, cesspool, etc.	7,626,000 87.0%	1,936,000 86.9%	4,557,000 41.5%
Direct discharges	789,000 9.0%	143,000 6.4%	275,000* 2.5%
Unknown	158,000 1.8%	78,000 3.5%	198,000 1.8%
Total	8,765,000 100.0%	2,228,000 99.9%	10,981,000 100.1%

*Direct household discharges included wastewater that drained to a pond, lake, stream, or an on-premise body of water directly receiving the household's wastewater. Also included in this category are composting or biological disposal systems, privies, and drain fields, as well as wastewater that was simply dumped on the ground. No judgment is intended as to the appropriateness of these methods.

Each figure in the table is rounded independently; numbers and percentages may not equal rounded totals.

percent of the nation's households), at least one breakdown had lasted six hours or longer. These severe breakdowns had occurred at most twelve times during the year.

Breakdowns most frequently consisted of septic tanks and similar arrangements becoming inoperative (at 65.2 percent of households reporting breakdowns). In fact, such breakdowns were reported with a frequency disproportionate to the number of such systems. In 25.4 percent of the households with breakdowns, toilets, pipes, or other related equipment at the household failed. At 7.4 percent, the breakdown was associated with failures of public sewer systems. At a small number of households (2.0 percent), the wastewater system became inoperative because of a lack of water.

Regional variation in wastewater system breakdowns

The proportion of households where breakdowns had occurred varied by one percentage point or less from region to region. Likewise, in each region, when breakdowns did occur, they were generally severe, lasting more than six hours at any given household.

Although the proportions of households experiencing wastewater system breakdowns varied very little from region to region, the reasons for the breakdowns varied considerably, and were related to the type of wastewater disposal system being used by the household. As seen in Table III-55, failures of septic tanks and similar arrangements accounted for breakdowns in 79.8 percent of the households that reported breakdowns in the West, but in only 54.5 percent in the Northeast. Breakdowns in household facilities occurred least often in the Northeast (at 20.7 percent of households), and most often in the North Central (at 28.2 percent of households). As to public sewer systems, the most pronounced problems were identified in the Northeast, where 14.6 percent of the breakdowns were attributed to public disposal systems becoming inoperative. Also, while only a small number

Table III-55

Regional Variation in Causes of Wastewater System Breakdowns

	Number and Percent of Households			
Cause of Breakdown	Northeast	North Central	South	West
Septic tank, cesspool or other disposal device became inoperative	106,000 54.5%	217,000 64.7%	305,000 61.2%	181,000 79.8%
Breakdown in household facilities	40,000 20.7%	94,000 28.2%	132,000 26.4%	48,000 21.1%
Water was unavailable	5,000 2.6%	0 0.0%	18,000 3.7%	0 0.0%
Public sewage disposal system was inoperative	28,000 14.6%	24,000 7.1%	31,000 6.3%	7,000 2.9%
*Total Households	194,000	335,000	499,000	227,000

*Table includes those households which reported one or more wastewater system breakdowns.

Each figure in the table is rounded independently; numbers and percentages may not equal rounded totals.

of households in the Northeast and South reported that wastewater systems became inoperative because of a lack of water, this reason was never reported by households in the North Central or West.

In a comparison of septic tank systems and public disposal systems, the data suggested that for all regions, public sewer systems accounted for a much smaller proportion of breakdowns than did septic tanks and similar arrangements. As seen in Table III-55, these differences were enormous: in each region, there was a difference amounting to 40 percentage points or more. (To some extent, the differences reflected the relative frequencies of the two basic types of wastewater systems; nonetheless, the data clearly indicated that public sewer systems were more reliable than septic tank arrangements.)

SMSA/nonSMSA variation in wastewater system breakdowns

The SMSA/nonSMSA comparison showed little variation in the frequency of wastewater system breakdowns or severe breakdowns. Among both SMSA and nonSMSA households, breakdowns were most frequently related to septic tanks and similar arrangements becoming inoperative (at 67.4 percent of SMSA households and 60.8 percent of nonSMSA households). Breakdowns in household facilities were equally common among SMSA and nonSMSA households; they were cited as the reason for breakdowns in roughly one of every four of these households. Breakdowns were associated with public sewer systems at 8.2 percent of nonSMSA households and 3.6 percent of SMSA households. They were attributed to water not being available at 2.5 percent of nonSMSA households, but at none of the households within SMSAs.

Size-of-place variation in wastewater system breakdowns

Wastewater system breakdowns were reported at 7.9 percent of households in small rural communities, at 5.1 percent in large rural communities, and at 5.8

percent in other rural areas. The size-of-place comparison showed little variation from the national estimate of 4.3 percent in the proportion of households having severe breakdowns.

The comparison showed a great deal of variation in the causes of wastewater system breakdowns. For example, in large rural communities (where public sewer systems were widely used), 45.1 percent of the households experiencing breakdowns said the breakdowns consisted of public disposal system failures, and 34.1 percent attributed the breakdowns to septic tank failures (see Table III-56). In other rural areas, as would be expected, breakdowns in public sewer systems were cited by only 2.3 percent of the households that had experienced breakdowns. Septic tank arrangements, which were more prevalent in other rural areas, accounted for breakdowns in 69.8 percent of the households that reported breakdowns.

Meaningful differences were also identified in the occurrence of breakdowns of household facilities. In small rural communities, such failures were reported at 40.7 percent of the households where breakdowns occurred, compared to 24.9 percent in other rural areas and 10.2 percent in large rural communities. Water unavailability affected a greater proportion of households in large rural communities (5.0 percent of them) than households in either of the other size-of-place groupings.

Size-of-system variation in wastewater system breakdowns

When households were compared as to the size of water system serving them, the only differences pertaining to wastewater system breakdowns were in the causes of the breakdowns. For example, the larger the size of the water supply system, the smaller the number of breakdowns relating to septic tank failures. More specifically, failures were attributed to septic tanks becoming inoperative at 79.1 percent of rural households served by individual water supply systems, 60.5

Table III-56

Size-of-Place Variation in Causes of Wastewater System Breakdowns

	Number and Percent of Households		
Cause of Breakdown	Large Rural Communities	Small Rural Communities	Other Rural Areas
Septic tank, cesspool or other disposal device became inoperative	38,000 34.1%	45,000 41.0%	736,000 69.8%
Breakdown in household facilities	11,000 10.2%	45,000 40.7%	262,000 24.9%
Water was unavailable	6,000 5.0%	0 0.0%	19,000 1.8%
Public sewage disposal system was inoperative	50,000 45.1%	19,000 17.3%	24,000 2.3%
Total Households	111,000	110,000	1,054,000

*Total includes those households which reported one or more wastewater system breakdowns.

Each figure in the table is rounded independently; numbers and percentages may not equal rounded totals.

percent of households served by intermediate systems, and 54.4 percent of those served by community systems. Breakdowns in household facilities were more prominent among households served by intermediate systems (31.9 percent) and community systems (28.4 percent) than among households using individual systems (18.5 percent). Since households on individual and intermediate water supply systems usually provided their own systems for wastewater disposal, none of these households reported that breakdowns were caused by failures of public sewer systems. In contrast, 13.8 percent of households served by community systems attributed breakdowns to a nonfunctional public sewer system (see Table III-57).

SUMMARY, WASTEWATER SYSTEMS

Almost two-thirds of rural households (64.3 percent, or 14.1 million) used either a septic tank, cesspool, or similar arrangement for disposal of wastewater, while 28.7 percent (6.2 million) were connected to public sewer systems. Direct discharges of wastewater were made at about 6 percent of rural households.

The West had the greatest proportion of households using public sewer systems (42.7 percent), and the smallest proportions of septic tank and similar arrangements (55.2 percent) and direct discharges (1.5 percent). The Northeast had the highest proportion of rural households using septic tanks and the like (74.7 percent), and the smallest proportion using public sewer systems (22.6 percent). Direct discharges were most common in the South, occurring at 9.7 percent of rural households—more than double the proportion in any other region.

Only 23.1 percent of nonSMSA households used public sewer systems, compared to 39.3 percent of SMSA households. Conversely, 67.4 percent of nonSMSA households used septic tanks, cesspools, and the like, compared to 57.6 percent of households within SMSAs. Direct discharges were far more common among nonSMSA households (8.2 percent, compared to only 1.6 percent of SMSA households).

Table III-57

Size-of-System Variation in Causes of Wastewater System Breakdowns

	Number and Percent of Households		
Cause of Wastewater System Breakdown	Individual Water Supply System	Intermediate Water Supply System	Community Water Supply System
Septic tank, cesspool or other disposal device became inoperative	377,000 79.1%	75,000 60.5%	367,000 54.4%
Breakdown in household facilities	88,000 18.5%	40,000 31.9%	191,000 28.4%
Water was unavailable	11,000 2.4%	0 0.0%	13,000 2.0%
Public sewage disposal system was inoperative	0 0.0%	0 0.0%	93,000 13.8%
*Total Households	477,000	124,000	674,000

*Total includes those households which reported one or more wastewater system breakdowns.

Each figure in the table is rounded independently; numbers and percentages may not equal rounded totals.

The size-of-place comparison showed quite different patterns of wastewater disposal. Public sewer systems were used by 71.9 percent of households in large communities and by 50.0 percent in small communities, but by only 20.8 percent in other rural areas. Septic tank and similar arrangements were used in 25.8 percent of households in large communities, 44.0 percent of households in small communities, and 70.9 percent of households in other rural areas. Direct discharges, almost nonexistent in large rural communities, occurred at 4.8 percent of households in small rural communities and 6.1 percent of households in other rural areas.

Wastewater systems showed strong variation depending on the size of water supply system serving the household. About 87 percent of households served by individual or intermediate water supply systems used septic tanks or cesspool arrangements. More than half of the households served by community systems (54.3 percent) used public sewer systems, while 41.5 percent used septic tank arrangements. Direct discharges occurred at 9.0 percent of households served by individual water supply systems, compared to 6.4 percent of those using intermediate systems and 2.5 percent of those using community water supply systems.

Breakdowns in wastewater systems had occurred in the year prior to the NSA at 6.1 percent of all rural households in the US (1.3 million). For the most part, the breakdowns were limited to only one or two occurrences. At 4.3 percent of rural households, the breakdown was severe in that it lasted for six hours or longer. More than two-thirds of the breakdowns consisted of septic tank arrangements becoming inoperative; one-quarter consisted of breakdowns of toilets, pipes, or related equipment; at 7.4 percent of the rural households where wastewater systems failed, the breakdown was associated with public sewer facilities. Subnational comparisons showed some differences in the causes of wastewater system breakdowns, but for the most part the differences simply reflected the varying frequencies of the different types of wastewater systems.

ORIENTATION TOWARD SUPPLY

The preceding portions of this chapter described demographic characteristics of rural households and household heads, the ways in which rural households use their major water supply, and the water-using fixtures and devices present in rural households. In this section of Chapter III, the focus shifts to rural water users' attitudes and preferences—their orientation—toward their water supplies. A user's attitudes are significant because they are likely to affect decisions about water use and may motivate any actions a user takes to improve a supply situation. For example, even though the water from the major supply is safe to drink, if the user finds the taste or color unappealing, he may drink less or even turn to an alternate supply.

To acquire pertinent information about water users' attitudes and preferences in rural America, the NSA solicited opinions on a number of subjects related to household water supplies. These included liked and disliked characteristics of the present household water supply, a comparison of the user's present supply with a hypothetical "ideal" supply, and the user's preferences regarding supply system size and ownership. The findings here reflect general attitudes toward the major household water supply; more specific opinions dealing with water quality and other characteristics of the water supply are presented as perceptual information in the relevant sections of Chapter V.

LIKED AND DISLIKED CHARACTERISTICS OF WATER SUPPLIES

Liked and disliked characteristics in rural US

Respondents were asked to identify spontaneously any characteristics of their supplies which they particularly liked or disliked. About fourteen million rural households (63.8 percent) specified at least one characteristic of their water supply that was particularly liked. The water's taste was specified as pleasing in 29.3 percent of the households. No other single characteristic was mentioned in more than 10 percent, though in about 8 to 10 percent of households, the amount, temperature, reliability, and softness of the supply were specified (see Table III-58 for exact proportions).

About 9.7 million rural households (44.4 percent) mentioned that there was a characteristic of the water supply which they particularly disliked. Many different characteristics were cited, but only two were disliked in about 10 percent or more of rural households across the US—taste (9.9 percent) and hardness (12.1 percent).

Regional variation in liked and disliked characteristics of water supplies

Of those characteristics that were mentioned as being particularly liked, only taste, reliability, and temperature showed regional variation of five percentage points or more (see Table III-58). Temperature was identified as a particularly liked characteristic less often in the South than in any other region (5.6 percent of households); in the West, it was mentioned in 14.8 percent of households. Differences across regions were less striking with regard to reliability and the amount of water available to the household. The water supply's reliability was particularly liked in 6.2 percent of households in the North Central, compared to 11.3 percent in the West. Having enough water (the amount) was mentioned in a smaller proportion of households in the West (7.3 percent) than in the Northeast (11.6 percent); in the North Central and South, the amount was mentioned as a liked characteristic at about 10 percent of households.

Only one particularly disliked characteristic—hardness—showed substantial regional variation. Nationwide, hardness was mentioned in about 12 percent of rural households, but it was mentioned as a disliked characteristic most often in the North Central and West (about 18 percent of households, compared to 14.4 percent in the Northeast and only 5.0 percent in the South). For taste, which was

Table III-58

Liked Characteristics of the Major Household Water Supply: US and Regional Variation

Liked Characteristic	Percent of Households				
	Nation	Northeast	North Central	South	West
Taste	29.3	29.6	32.9	26.9	28.8
Softness	7.9	5.2	7.2	9.3	8.7
Reliability	8.2	7.9	6.2	8.8	11.3
Temperature	8.6	11.0	8.9	5.6	14.8
Amount of water	9.9	11.6	9.8	9.9	7.3
Total Households	21,974,000	3,693,000	6,213,000	9,291,000	2,777,000

mentioned as a disliked characteristic at approximately 10 percent of households across the nation, no significant regional variation was detected.

SMSA/nonSMSA variation in liked and disliked characteristics of water supplies

The SMSA/nonSMSA comparison showed little or no difference in the proportions of rural households identifying liked and disliked characteristics of their water supplies. In fact, the largest difference was only four percentage points, which occurred for a single liked characteristic (amount) and for one disliked characteristic (hardness). In both instances, nonSMSA households indicated greater satisfaction with their water supplies. That is, a larger proportion of nonSMSA households specifically mentioned that they liked the amount of water provided by the supply (11.1 percent, compared to 7.1 percent of SMSA households), and a smaller proportion of nonSMSA households specified hardness as something they disliked about the supply (10.8 percent, compared to 14.9 percent of SMSA households).

Size-of-place variation in liked and disliked characteristics of water supplies

For the most part, the size-of-place comparison showed little variation in the proportions of households where various characteristics were particularly liked. While the taste of the water supply was mentioned as a liked characteristic at 33.0 percent of households in small rural communities and 30.4 percent of households in other rural areas, it was mentioned at only 18.4 percent of households in large rural communities. The temperature of the water supply was a liked characteristic more often in other rural areas than elsewhere; it was mentioned at 9.9 percent of households in other rural areas but at only 4.1 percent of households in small rural communities and 1.6 percent of households in large rural communities.

Among disliked characteristics, only hardness showed any variation in the size-of-place comparison. Specifically, hardness was identified as a disliked characteristic at 12.7 percent of households in other rural areas, compared to 9.1 percent in large communities and 9.7 percent in small communities.

Size-of-system variation in liked and disliked characteristics of water supplies

When households served by supply systems of various sizes were compared, substantial variation was detected in the proportions of households mentioning various characteristics that were particularly liked (see Table III-59). Immediately apparent was the fact that households served by individual and intermediate systems showed similar patterns of responses which contrasted with households served by community systems. For example, taste, temperature, and the quantity of water were mentioned as particularly liked characteristics less often among households served by community systems. On the other hand, community systems more frequently were identified as reliable than individual or intermediate systems.

As for disliked characteristics, the taste of the water supply was mentioned as being disagreeable twice as often among households served by community systems—13.8 percent, compared to 6.1 percent served by individual systems and 5.8 percent served by intermediate systems. On hardness, responses from households served by intermediate systems were more like those from households served by community systems: 9.3 percent served by intermediate systems and 10.1 percent served by community systems mentioned hardness as a disliked characteristic, compared to 15.3 percent of households served by individual systems.

COMPARISON WITH IDEAL SUPPLY

Comparison with ideal supply in rural US

After respondents had identified liked and disliked characteristics of their household water supplies, they were asked to compare the household supply with

Table III-59

Size-of-System Variation in Liked Characteristics of Household Water Supplies

Liked Characteristic	Percent of Households Individual System	 Intermediate System	 Community System
Taste	37.1	38.8	21.5
Reliability	5.4	6.0	11.0
Temperature	12.4	15.1	4.4
Amount of water	11.5	15.4	7.6
*Total Households	8,709,000	2,199,000	10,929,000

*Table includes only those households which identified one or more of the characteristics listed in the table.

one that possessed all the characteristics people usually desire in a water supply. The water from this hypothetical "ideal" supply was cold, clear, and good to drink; also, the pressure was satisfactory and the supply always provided an adequate amount of water.

In 15.8 million households (72.0 percent), the household supply was reported to be equal to this ideal supply. However, in over five million households, or 23.9 percent, the ideal supply was judged superior to the existing one. At the remaining 4.1 percent or 0.9 million households, the household water supply was considered superior to the ideal supply.

Subnational variation in comparison with ideal supply

As shown in Table III-60, an approximately equal proportion of respondents in each region judged their household supply better than the ideal supply. However, in the North Central and Northeast, a larger proportion of households reported that the two were equal, and a smaller proportion reported that the ideal supply was better. The largest regional difference was found between the North Central and West. Specifically, at 76.2 percent of North Central households, compared to 68.9 percent in the West, the two supplies were judged equal. The ideal supply was judged superior more frequently in the West than in the North Central (27.0 percent versus 19.9 percent).

No significant difference was found in the comparison of SMSA and nonSMSA households.

Again, there was little variation when households in large rural communities, small rural communities, and other rural areas were compared. The largest difference amounted to slightly less than five percentage points: in large communities, the ideal supply was considered superior in 27.7 percent of households, compared to 23.2 percent of households in other rural areas. Conversely, in

Table III-60

Regional Variation in Comparison with Ideal Supply

	Percent of Households			
Comparison	Northeast	North Central	South	West
Household supply is superior	4.3	3.9	4.2	4.1
Household supply is equal to ideal supply	73.4	76.2	69.6	68.9
Ideal supply is superior	22.3	19.9	26.2	27.0
Total Percent	100.0	100.0	100.0	100.0
Total Households	3,693,000	6,213,000	9,291,000	2,777,000

large communities the household supply was considered superior less often than in other rural areas, although the difference in the proportions was very small.

Nationwide, the household supply was judged superior to the ideal supply only infrequently. However, the size-of-system comparison revealed that this response was more common among households served by individual systems (6.3 percent of individual-system households, compared to 4.2 percent of households served by intermediate systems and 2.4 percent of households served by community systems). The household supply was judged equal to the ideal supply in 71.7 percent of households served by an individual system and 71.3 percent served by a community system, compared to 76.3 percent of households served by intermediate systems. The ideal supply was judged superior to the household supply most often among households served by community systems (26.2 percent). This finding is consistent with other NSA data which suggested that water supplied by smaller systems more often was thought superior to water supplied by community systems (see "Size-of-system variation in liked and disliked characteristics of water supplies," above).

PREFERENCES FOR ALTERNATE SYSTEMS

Preferences for alternate systems in rural US

The preference in most rural households (18.1 million) was to continue to receive water from the present system. However, in 3.9 million households (17.8 percent), a different system was preferred.

When a different system was preferred, the reasons most frequently cited were the taste of the water (27.9 percent of the households preferring a different system), the healthfulness of the water (19.0 percent), and the convenience of the system (15.0 percent). Other reasons for wanting a different system were related to the amount of water supplied (13.3 percent), the cost of the water supply (13.2

percent), and the reliability of the supply (11.6 percent). Also, softer water was desired at 10.2 percent of the households wanting a different system.

In addition to being asked why they preferred a different system, respondents were asked about system size and ownership preferences. In 40.0 percent of households where a system change was preferred, an individual system was desired; in 12.0 percent, an intermediate system was preferred; and in 46.2 percent, a community system was preferred. As would be expected, ownership patterns were chosen which were consistent with size preferences. In more than 90 percent of households in which individual systems were preferred to current ones, "in-house ownership" also was preferred. In households indicating preferences for community systems, the following forms of ownership were preferred: public ownership (72.6 percent), cooperative ownership (13.6 percent), and ownership by a private firm (9.2 percent).

Regional variation in preferences for alternate systems

Preferences for alternate systems were least frequent in the North Central and most frequent in the West (see Table III-61). Specifically, 86.3 percent of households in the North Central preferred their present system, compared to 77.4 percent in the West. Almost 23 percent of households in the West desired a system change. In the Northeast and South, almost identical proportions of households—between 81 and 82 percent—preferred the present system, while about 18 percent desired a different system.

When a different system was preferred, the reasons cited varied considerably from region to region (see Table III-62). Taste, softness, and healthfulness of the water supply were often cited in the West as reasons for preferring a different system. Greater convenience was far more common a reason for preferring a different system in the North Central and South than in the Northeast and West.

Table III-61

Regional Variation in Supply System Preferences

	Percent of Households			
Preference	Northeast	North Central	South	West
Present water supply system	81.7	86.3	81.1	77.4
Different water supply system	18.2	13.6	18.9	22.6
Total Percent	99.9	99.9	100.0	100.0
Total Households	3,693,000	6,213,000	9,291,000	2,777,000

Table III-62

Regional Variation in Reasons Cited for Preferring an Alternate System

	Percent of Households				
Reason	Nation	Northeast	North Central	South	West
Taste	27.9	25.1	27.9	25.8	36.6
Softness	10.2	1.9	13.9	5.3	28.0
Convenience	15.0	8.6	19.7	20.6	1.7
Reliability	11.6	20.5	3.9	15.1	2.9
Healthfulness	19.0	18.9	12.7	19.6	25.9
Cost	13.3	10.4	13.2	14.1	13.5
Quantity	13.2	13.7	9.3	15.5	12.1
*Total Households	3,900,000	660,000	846,000	1,760,000	628,000

*Table includes only those households which preferred a different water supply system. Column totals do not equal 100 percent because more than one reason could be cited, and because reasons that were mentioned only infrequently were excluded from the table.

Reliability appeared to be of concern more frequently in the Northeast and South than in the North Central and West.

In every region but the Northeast, a community system was the most frequently preferred type of alternate system (see Table III-63). In the Northeast, however, an individual or single-connection system was preferred most frequently. In the other regions, the pattern of preferences was consistent, although the proportions varied: community systems were most often preferred, followed by individual systems and intermediate systems. Of all regions, the Northeast showed the strongest preference for individual systems, while intermediate systems were preferred far less frequently than in other regions. The proportions of households where community systems were preferred were very similar from one region to another.

Ownership preferences were generally consistent with size preferences, at least regarding individual and community systems. For example, about 50 percent of households in the Northeast preferred an individual system, and 46.0 percent preferred ownership by a household member (compare Tables III-63 and III-64). Similarly, a like number of households in the North Central preferred an individual system and ownership by a household member. This pattern held true for the South and West as well. Likewise, a similar relationship was evident between preferences for community systems and for public ownership. One exception was detected, however: of the households in the West where a different system was preferred, 46.8 percent preferred a community system but only 26.3 percent preferred public ownership. (More households in the West preferred cooperative ownership (27.6 percent) or ownership by a private firm (13.6 percent).

While system size and ownership preferences were generally consistent with one another, ownership preferences varied substantially from region to region (see Table III-64). For example, ownership by someone in the household itself was most preferred in the Northeast (46.0 percent) and least preferred in the West (29.9

Table III-63

Regional Variation in System Size Preferences

Preferred System Size	Percent of Households: Northeast	North Central	South	West
Individual	49.9	34.1	41.1	34.4
Intermediate	5.3	16.3	10.1	18.8
Community	43.0	46.5	47.0	46.8
Don't know	1.7	3.2	1.8	0.0
Total Percent	99.9	100.1	100.0	100.0
*Total Households	659,000	846,000	1,760,000	628,000

*Table includes only those households which preferred a different water supply system.

Table III-64

Regional Variation in Ownership Preferences

Preferred Type of Ownership	Percent of Households			
	Northeast	North Central	South	West
Owned by member of the household	46.0	35.0	39.8	29.9
Privately owned system but owned by someone outside household	2.1	3.4	5.9	2.7
Publicly owned system	41.3	47.8	41.9	26.3
Owned by a cooperative	7.1	12.8	5.2	27.6
Owned by a private firm	3.4	0.9	7.1	13.6
Total Percent	99.9	99.9	99.9	100.1
*Total Households	659,000	846,000	1,760,000	628,000

*Table includes only those households which preferred a different water supply system.

percent). Publicly owned systems were preferred in 47.8 percent of households in the North Central but in only 26.3 percent in the West. Finally, preferences for cooperative ownership varied markedly between the West and South (27.6 percent in the West and 5.2 percent in the South).

SMSA/nonSMSA variation in preferences for alternate systems

There was little difference between SMSA and nonSMSA households in the proportions stating a preference for an alternate water supply system. About 18 percent of both SMSA and nonSMSA households preferred an alternate system. However, reasons cited for the preferences varied a great deal.

The proportion of nonSMSA households citing convenience as a reason was more than twice that of households within SMSAs (19.0 percent versus 8.6 percent). Other reasons reported more frequently in households located outside SMSAs were reliability (18.1 percent versus 13.7 percent) and quantity (15.8 percent versus 8.9 percent). On the other hand, SMSA households more often cited two complaints about water quality—taste and softness—as reasons for preferring a different system. That is, 38.0 percent of SMSA households preferred a system change because of taste, compared to only 22.1 percent of nonSMSA households. Similarly, the proportion of SMSA households reporting a desire for softer water was almost twice that of nonSMSA households (14.2 percent versus 8.0 percent). Little difference (about two percentage points) was noted in the proportions of households inside and outside SMSAs citing cost and healthfulness as reasons for desiring a system change.

Ownership preferences were generally consistent with size preferences for households located both inside and outside SMSAs. For example, of the SMSA households that preferred an alternate system, about 38 percent preferred an individual system and about 36 percent preferred ownership by a household member. The proportions were similar for nonSMSA households: specifically, of the nonSMSA households desiring a system change, 41.0 percent preferred an individual system and 39.0 percent preferred ownership by a household member. Among nonSMSA households, there were parallel preferences for a community system and public ownership; that is, an equal proportion of households, approximately 45 percent, reported these two preferences. The one ostensible exception to these parallel findings was that 48.1 percent of SMSA households desiring a system change preferred a community system, but only 32.8 percent preferred public ownership. In this case, however, preferences for cooperative ownership and ownership by a private firm accounted for the difference in the percentages.

Intermediate systems were preferred about equally by SMSA and nonSMSA households (10.8 percent and 12.7 percent, respectively), but no clear parallel could be drawn between preferences for intermediate systems and forms of ownership.

Considering ownership preferences separately from system size preferences, cooperative ownership and ownership by a private firm were preferred much more often among SMSA households than among nonSMSA households. Cooperative ownership was preferred by 16.4 percent of SMSA households, compared to only 7.5 percent of nonSMSA households. Ownership by a private firm was preferred by 11.5 percent of SMSA households, as opposed to only 3.2 percent of nonSMSA households. Although mentioned infrequently as a preference, private ownership by an individual who was not a member of the household was preferred in 5.9 percent of households located outside of SMSAs, but in only 1.1 percent of households within SMSAs.

Size-of-place variation in preferences for alternate systems

Households located in other rural areas stated a preference for a different water supply system more often than those in large or small rural communities. A different system was preferred by 18.5 percent of households in other rural areas, 15.6 percent of households in large rural communities, and 12.4 percent of households in small rural communities. Interestingly, the reasons for preferring a system change differed substantially (see Table III-65). Taste and softness were given as reasons for preferring a different system more often in small communities and other rural areas than in large communities. Convenience and reliability were mentioned far more frequently among households in other rural areas than among households in large or small communities. Healthfulness was the reason for preferring a system change more often among households in large rural communities and other rural areas than among those situated in small rural communities. Cost and the quantity of the water supply were the reasons for preferring a different system in roughly similar proportions of households in the three size-of-place categories, except that quantity was given as the reason less frequently in small rural communities.

Among households where a different system was preferred, almost half in large rural communities and other rural areas stated a preference for community systems (see Table III-66). In small rural communities, over half preferred an individual system, and only 28.5 percent preferred a community system. Intermediate systems were preferred at similar proportions of households in the three size-of-place categories.

With respect to ownership preferences, little variation was detected among households in the three size-of-place categories. However, ownership by a private individual other than a household member was preferred more than twice as often in small rural communities as in large rural communities or other rural areas (see Table III-67). A publicly owned system was preferred most often in large rural communities and least often in small rural communities. Cooperative ownership was mentioned most often in other rural areas.

Table III-65

Size-of-Place Variation in Reasons Cited for Preferring an Alternate System

Reason	Percent of Households Large Rural Communities	Small Rural Communities	Other Rural Areas
Taste	22.3	31.4	28.6
Softness	5.7	11.9	10.7
Convenience	3.1	0.0	17.7
Reliability	6.1	2.6	12.9
Healthfulness	21.7	15.8	19.1
Cost	14.1	15.3	13.1
Quantity	14.2	10.7	13.5
*Total Households	3,312,000	187,000	368,000

*Table includes only those households which preferred a different water supply system. Column totals do not equal 100 percent because more than one reason could be cited, and because reasons that were mentioned only infrequently were excluded from the table.

Table III-66

Size-of-Place Variation in System Size Preferences

Preferred System Size	Percent of Households Large Rural Communities	Small Rural Communities	Other Rural Areas
Individual system	32.8	56.4	39.9
Intermediate system	14.4	15.1	11.6
Community system	47.1	28.5	47.1
Don't know	5.7	0.0	1.5
Total Percent	100.0	100.0	100.1
*Total Households	368,000	187,000	3,311,000

*Table includes only those households which preferred a different water supply system.

Table III-67
Size-of-Place Variation in Ownership Preferences

Preference	Percent of Households Large Rural Communities	Small Rural Communities	Other Rural Areas
Owned by member of the household	38.2	43.6	38.0
Privately owned system but owned by someone outside household	5.1	11.5	3.7
Publicly owned system	44.4	38.8	40.2
Owned by a cooperative	9.1	6.1	11.2
Owned by a private firm	3.2	0.0	6.9
Total Percent	100.0	100.0	100.0
*Total Households	368,000	187,000	3,311,000

*Table includes only those households which preferred a different water supply system.

Size-of-system variation in preferences for alternate systems

Preferences for alternate water supply systems varied only slightly depending on the size of the system currently serving the household. A desire for a different system was stated in 19.0 percent of households served by individual systems, 17.3 percent served by community systems, and 15.0 percent served by intermediate systems.

The reasons for preferring an alternate system varied considerably, however. Interestingly, almost 45 percent of the households which were served by community systems and which desired a system change mentioned an undesirable taste in the water supply as the reason (see Table III-68). In contrast, only about 12 percent of households served by individual or intermediate systems mentioned taste as a reason for preferring a different system. (This finding is consistent with data presented in Chapter V which show that households served by community systems reported tastes in their water supplies more often than households served by individual or intermediate systems. The tastes were generally attributed to water treatment practices such as chlorination.)

Other reasons for preferring a system change also varied depending on the size of the water supply system currently serving the household. Reasons that were stated by sizable proportions of households served by community systems were cost, softness, and healthfulness (see Table III-68). Among households served by individual systems, preferences for a different system frequently were related to convenience, reliability, and the quantity of water desired. For example, convenience was the reason given at about 34 percent of households served by individual systems, though it was never mentioned at households served by community systems. Again, reliability was the reason for preferring a different system at about 17 percent of households served by individual systems, compared to about 7 percent of households served by community systems; quantity was the

Table III-68

Size-of-System Variation in Reasons Cited for Preferring an Alternate System

Reason	Percent of Households Individual System	Intermediate System	Community System
Taste	12.6	11.6	44.4
Softness	4.2	12.3	15.2
Convenience	34.1	11.6	0.0
Reliability	17.1	14.1	6.7
Healthfulness	16.3	19.1	21.6
Cost	10.3	6.2	17.2
Quantity	23.2	14.3	4.9
*Total Households	1,635,000	333,000	1,898,000

*Table includes only those households which preferred a different water supply system. Column totals do not equal 100 percent because more than one reason could be cited, and because reasons that were mentioned only infrequently were excluded from the table.

reason given at about 23 percent of households served by individual systems and about 5 percent served by community systems.

Further questioning at households where a different water supply system was preferred tried to ascertain whether the preference centered on a different system size or a different form of system ownership. With respect to system size, preferences in relation to a new supply were very similar among households currently served by individual and by intermediate systems: over 50 percent preferred to be served by commmunity supply systems, and about 37 percent preferred individual systems (see Table III-69). On the other hand, 43.1 percent of households served by community systems preferred individual systems, and close to 15 percent preferred intermediate systems. Thus system size was sometimes but not always a factor in preferences for different supply systems. Considering only those households where a system change was desired, 41.1 percent of those households served by community systems were satisfied with the size of their current system. Likewise, 37.1 percent of those households that were served by individual systems were satisfied with that size of system. However, the same was true of only 9.4 percent of the households served by intermediate systems, indicating that among these households, problems that made a system change desirable were almost always attributed to the size of the system.

Ownership preferences were consistent with system size preferences. Among households served by individual and intermediate systems, public ownership was the most preferred form and individual ownership second most preferred (see Table III-70). Among households served by community systems, almost 41 percent preferred a system that was owned by a household member while about 34 percent preferred public ownership. (These findings correspond closely with those regarding system size preferences, presented in Table III-69.) Other forms of ownership were preferred less often but, interestingly, 10.9 percent of households served by community systems mentioned ownership by a private firm as the preferred kind.

Table III-69

Size-of-System Variation in System Size Preferences

	Percent of Households		
Preferred System Size	Individual System	Intermediate System	Community System
Individual system	37.1	36.9	43.1
Intermediate system	9.4	9.4	14.8
Community system	50.5	53.7	41.1
Don't know	2.9	0.0	1.1
Total Percent	99.9	100.0	100.1
*Total Households	1,654,000	333,000	1,904,000

*Table includes only those households which preferred a different water supply system.

Table III-70

Size-of-System Variation in Ownership Preferences

Preferred Form of Ownership	Percent of Households Individual System	 Intermediate System	 Community System
Owned by member of the household	36.2	34.7	40.7
Privately owned system but owned by someone outside household	5.0	10.3	2.4
Publicly owned system	47.1	44.8	33.9
Owned by a cooperative	10.3	5.8	12.1
Owned by a private firm	1.4	4.4	10.9
Total Percent	100.0	100.0	100.0
*Total Households	1,654,000	333,000	1,904,000

*Table includes only those households which preferred a different water supply system.

SUMMARY, ORIENTATION TOWARD SUPPLY

Rural residents' general attitudes toward their water supplies were elicited in a series of questions about liked and disliked characteristics of their supplies, their general satisfaction with their supplies, and possible preferences for changing to a different supply.

About two-thirds of respondents identified a specific characteristic of the water supply which they liked—most often, taste. About 44 percent identified a specific characteristic which they disliked—again, taste was mentioned frequently, along with hardness.

Regional variation was not striking, though reliability was mentioned as a liked characteristic most often in the West and least often in the North Central, and temperature was mentioned as a liked characteristic most often in the West and least often in the South. Hardness was disliked by about 18 percent of rural households in both the North Central and West, compared to 5.0 percent in the South.

In the size-of-place comparison, the water supply's taste was liked far more often at households in small rural communities and other rural areas than at households in large rural communities. The temperature was liked far more often in other rural areas than in large or small communities.

The size-of-system comparison showed greater variation than others. Specifically, a much smaller proportion of households served by community water systems liked the water's taste and temperature, though a much larger proportion liked their supply for its reliability. Conversely, taste was mentioned as a disagreeable characteristic more than twice as frequently among households served by community systems. Hardness was mentioned as a disagreeable characteristic most often among individual-system households.

When respondents were asked to rate their current water supply against an ideal supply, 23.9 percent (about five million rural households across the US) judged the ideal supply better. This proportion varied from region to region, from about 20 percent in the North Central to 27.0 percent in the West. As to the size-of-place comparison, 23.2 percent of households in other rural areas thought the ideal supply was better, compared to 27.7 percent in large rural communities. In the size-of-system comparison, the ideal supply was judged superior most often among households served by community water systems.

Almost four million rural households (17.8 percent) stated a preference for changing to a different water system, most often because of the existing supply's taste. About 46 percent of those desiring a change stated a preference for a community system, and 40.0 percent stated a preference for an individual system. The form of ownership that was preferred was consistent with normal ownership patterns. That is, similar proportions of households would have preferred changing to an individual water system and having in-house ownership of the system. At households indicating a preference for a community system, preferences were for public ownership (72.6 percent), cooperative ownership (13.6 percent), and ownership by a private firm (9.2 percent).

Preferences for changing to a different water supply system were reported most commonly in the West (22.6 percent) and least commonly in the North Central (13.6 percent). Though taste was everywhere the most prominent factor in the desire for a change, it was cited far more frequently in the West. Other leading factors in the West were the softness and healthfulness of the water supply; in the Northeast, they were reliability and healthfulness; and in the South, they were convenience, healthfulness, and reliability.

A community system was the most frequently preferred type of alternative system in all regions except the Northeast, where individual systems were preferred most frequently. Ownership preferences varied substantially from region to region, with cooperative ownership being mentioned far more frequently in the West than in any other region.

Equal proportions of rural households inside and outside SMSAs (about 18 percent) stated a preference for a different system, and there was little difference in size preferences. Among nonSMSA households, the most important factors for those households desiring a change were convenience, reliability, and the quantity afforded by the supply, while taste and softness were mentioned more often by SMSA households than by nonSMSA households. As to ownership preferences, cooperative ownership and ownership by a private firm were preferred much more often among SMSA households than among nonSMSA households.

Preferences for a different water supply system were voiced most often among households located in other rural areas, and least often in small rural communities. The reasons for preferring a different system varied, but taste was mentioned most frequently regardless of a household's geographic location.

System size preferences also varied, with community systems being preferred most often in large rural communities and other rural areas, and individual systems being preferred most often in small rural communities. Ownership preferences ran parallel to these findings: publicly owned systems were preferred more often in large rural communities and other rural areas, while ownership by a household member was preferred most often in small rural communities.

A desire for a different system was stated with about equal frequency regardless of the size of system currently serving a household. However, there was variation in the reasons given for the preference. Among households served by community water systems and wanting a change in system, about half mentioned an undesirable taste as the reason, compared to only about 12 percent of those served by smaller systems and wanting a change. Other leading factors among households served by community water systems were healthfulness, cost, and softness. Among households served by individual systems, by far the most prominent reason had to do with convenience.

System size was sometimes a factor in preferences for different supply systems. Among households wanting a system change, about 41 percent served by community systems and 37 percent served by individual systems were satisfied with the size of their system, but this was true of only 9.4 percent of intermediate-system households. Ownership preferences paralleled system size preferences.

CONCLUSION: THE CONTEXT OF RURAL WATER SUPPLY

Demographics, water use, wastewater systems, attitudes about current water supplies—taken together, these disparate elements of Chapter III set a context for the main subject of the NSA, rural household water supply. Chapter IV reports the types of water supplies in use at rural households. Subsequent chapters delve into the status of rural water supply and the relationships found between various aspects of water supply status and other NSA findings, including those in Chapter III.

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[2] Schertz, Lyle P.; McArthur, W. C.; Lagrone, William Franklin; Johnson, Stanley S.; Jesse, Edward V.; and Reimund, Donn A., in Schertz, Lyle P. et al. Another Revolution in U.S. Farming? Washington, DC: US Department of Agriculture, 1979.

[3] Midwest Planning Service. Private Water Systems. Ames, Iowa: Iowa State University, 1968.

[4] Midwest Planning Service, 1968.

IV

US Rural Water Supplies and Water Sources

In addition to describing the demographic attributes of rural households, Chapter III presented information about the types of water-using fixtures and appliances, the uses which rural occupants made of their major water supply, and their general orientation toward their present supply as well as desires for changes. Chapter IV focuses on household water supplies and water sources. It identifies the general types of physical arrangements from which rural households obtain water and the origin, or source, of that water. In addition, the chapter addresses the implications of various supply situations that were found among rural households. Chapters III and IV contain complementary information; taken together, they provide a complete context for subsequent chapters.

Consistent with the definitions developed in Chapter II, "supply" referred to domestic water as it reached the household, or water manipulated in any way for transmission to rural households, and the facilities associated with the manipulation; "source" was the physical reserve of water within the hydrological cycle, broadly classified as groundwater, surface water, or precipitation. According to these definitions, a source could also become a supply since the two do not function independently. For example, surface water in the form of a lake, or groundwater in a particular aquifer, is simultaneously both a source and a supply when the necessary extraction and distribution facilities are installed. In this respect, the terms "source" and "supply" are not mutually exclusive; they differ only in the orientation that each suggests. They are distinguished in the NSA so as to delineate different components of the process by which water is secured and made available for human use and consumption.

The substance of this chapter begins with definitions of the various types of water supplies. Then, supplies are described for households with both simple and complex supply situations. The presentation focuses first on drinking water supplies, and tabulates the number of rural households using each type of supply for drinking water. Data are also presented on households having multiple drinking water supplies, and on the supply which is used most often for drinking at these households.

The next section of the chapter focuses on the major household water supply—the supply that satisfies most of a household's water requirements. Separate consideration is then given to households that do not employ the major supply for drinking, and to households that have supplementary water supplies, regardless of their use. The chapter concludes by focusing on water sources and assessing the frequency with which each source is used in the rural US.

Findings are organized to conform to the general structure of the preceding chapter. Specifically, national results are presented first, followed by groupings according to region, SMSA/nonSMSA, and size of place. Size-of-system differences are presented only in the section on water sources, as an adjunct to some of the material contained in Chapter VII. Otherwise, size-of-system variations are omitted because they would contribute only minimally to the description. Interspersed within the major sections of the chapter are other segments on unusual supply situations, such as households that purchase or haul water.

RURAL WATER SUPPLIES

Water supplies may be categorized by any number of criteria. In the NSA, water supplies were differentiated on the basis of their physical arrangements and whether or not they were used for drinking. Characterizing supplies in terms of their physical arrangements resulted in the following seven supply types: (1) multiple-connection systems which served fifteen or more households or more than 25 people (synonymous with the term "community supplies" or "community systems" in the NSA report), (2) wells, (3) springs, (4) surface water (pond, lake, river, or stream), (5) cisterns, (6) hauled water, and (7) purchased bottled water. As indicated in Chapter II, supplies were also divided into drinking water supplies and major household supplies. Theoretically, each of the seven physical types of supplies could provide water that the household used either exclusively for drinking or for other domestic purposes as well. Since complete definitions of drinking water supplies and major household supplies were presented in Chapter II, this segment of Chapter IV will present only the definitions of the seven supply types utilized in the NSA.

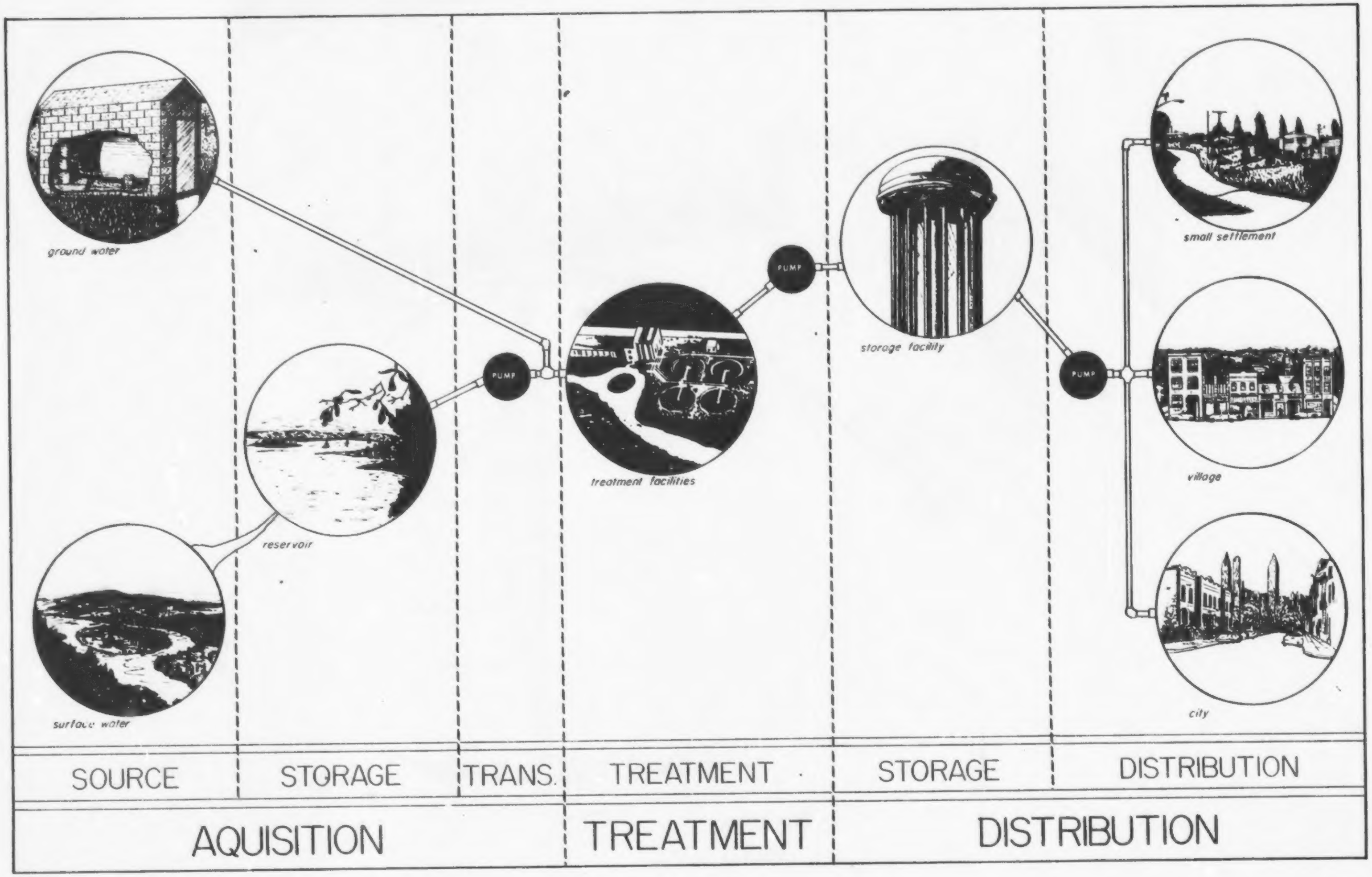
First, community systems were regarded as supplies in that they provide finished water for household use. Even though community systems may transmit water that has been extracted from wells, springs, surface water sources, or other types of water supplies, they were defined as a separate and distinct type of supply in the NSA because they represent a characteristic set of facilities that affect the condition of water between the point of withdrawal and the household. (In this chapter, the focus is on the physical aspects of water supply. Later in the report, the term "system" refers principally to the social organizational dimensions of the supply rather than to its physical aspects, a usage more in keeping with the definition developed in Chapter II. The distinction between supply and system, though difficult to maintain at times, becomes important for addressing issues of financing, economics, and regulation.)

The overriding consideration in distinguishing a community supply from some other type of supply was the number of connections to which water was conveyed, independent of any other physical attribute such as the water's source. Therefore, if a well supplied water to at least fifteen households, the groundwater, along with its associated extraction, processing, and distribution equipment, it was classified as a community supply in the NSA. However, if the same sort of supply provided water to fewer than fifteen households, it was considered a well. The same principle applied if the water originated from a surface water source, such as a river or lake, or from some other groundwater source, such as a spring. Figure IV-1 illustrates the general configuration of community supplies. For additional information on community supplies as a type of water system, and for a summary of the functions they perform as well as other characteristics, see Chapter VII. For additional information on the economics of community water systems, see Chapter VIII.

As to other types of supplies besides community supplies, a well supply was any shaft that was dug, driven, jetted, drilled, or bored into the ground for the purpose of acquiring water. The definition of a well supply also included the extraction devices and conveyances associated with that particular type of supply. With some well supplies, water is drawn from the ground by a manually operated pump and transported to the house in containers. Other well supplies extract water by an electric pump and transport it under pressure by means of an underground piping system. Figure IV-2 portrays the construction of one possible well supply.

Spring supplies were defined as physical arrangements that use groundwater which rises naturally to the earth's surface prior to human intervention. More specifically, a spring supply usually consists of a pipe inserted into the outlet of a water-bearing formation and an enclosed reservoir or catchment basin. If a spring is elevated sufficiently, its water can flow by gravity to the point of consumption; if not, the water must be pumped from the catchment basin to the

Figure IV-1
Community Supply


ground water
surface water
reservoir
PUMP
treatment facilities
PUMP
storage facility
PUMP
small settlement
village
city
SOURCE
STORAGE
TRANS.
TREATMENT
STORAGE
DISTRIBUTION
AQUISITION
TREATMENT
DISTRIBUTION

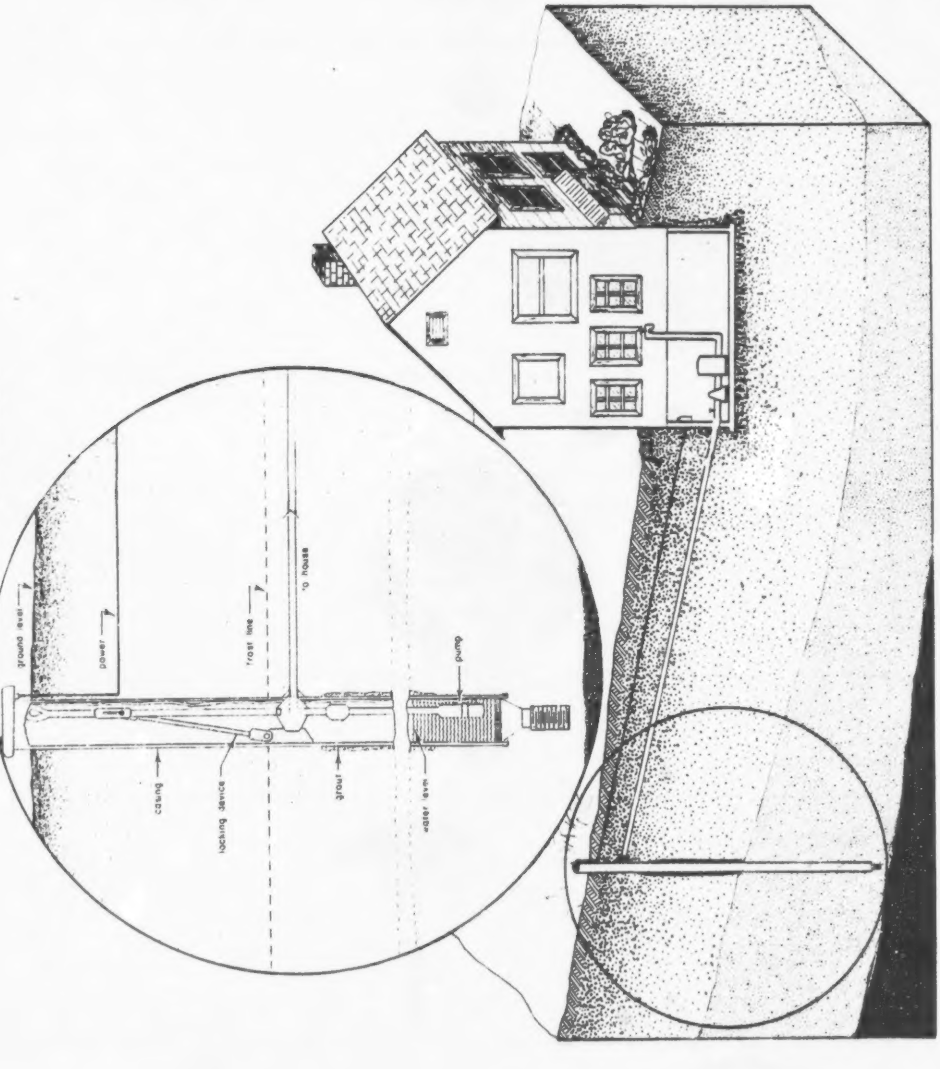

ground level
power
frost line
to house
pump
casing
locking device
grout
water level

Figure IV-2
Well Supply

house. Figure IV-3 illustrates one basic recommended configuration of a spring supply. (Most households using spring supplies would probably employ a simpler set-up.)

Grouped together in the NSA as surface water supplies were those that extracted water from lakes, ponds, rain- or spring-fed streams, reservoirs, impoundments, and other catchment areas. Generally, surface supplies extract water from a source by extending a pipe or intake structure into the water body at an appropriate depth. The physical facilities of surface water supplies usually consist of a pump, piping, and conditioning equipment, since surface water is typically treated or disinfected. The configuration of one type of surface water supply is shown in Figure IV-4.

Cistern supplies were defined as physical arrangements that utilize devices for collecting precipitation. In a stricter sense, a cistern simply stores water that has run off a building roof or the surface of a special collection structure. Depending upon the cistern's location, its water may flow by gravity to the house or may be transported under pressure. Figure IV-5 illustrates the components of a cistern supply.

Hauled and purchased bottled supplies are unlike the preceding supplies in that they are not represented by any definite physical arrangement. The term "hauled water" included any supply that was carried to the household by bucket, bottle, tank truck, or any conveyance other than a pipe—provided that the water was not obtained from a commercial distributor. In contrast, the term "purchased bottled water" referred to any water supplied by a commercial distributor of potable water, whether it was distributed in small containers or in bulk. More specifically, water was classified as purchased bottled if its acquisition involved an exchange of money and if it was in a finished form before reaching the household. If the water satisfied neither of these two conditions and if it was transported by a means other than piping, it was considered to be from a hauled supply.

Figure IV-3
Spring Supply

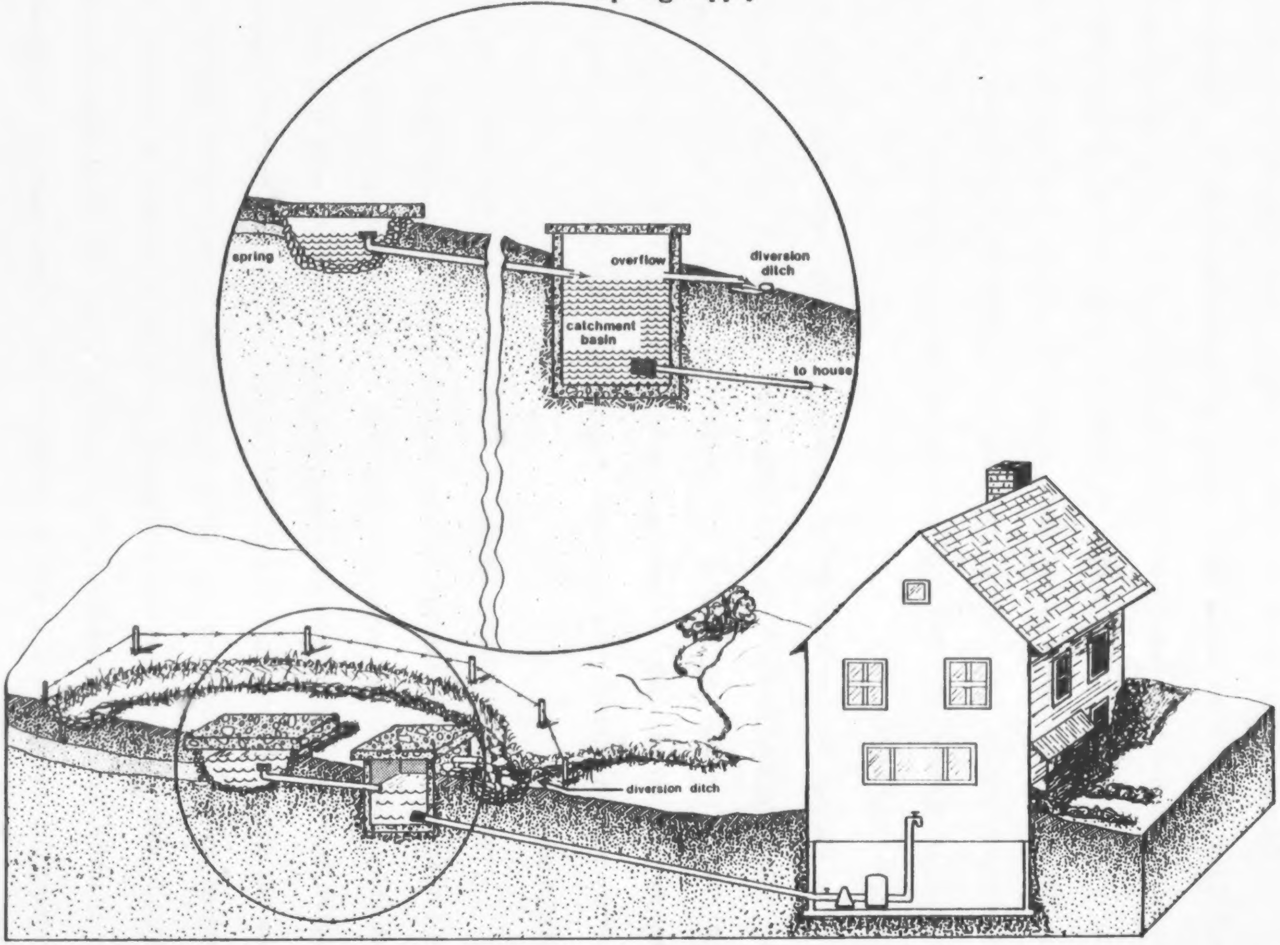

spring
overflow
diversion ditch
catchment basin
to house
diversion ditch

Figure IV-4
Surface Water Supply

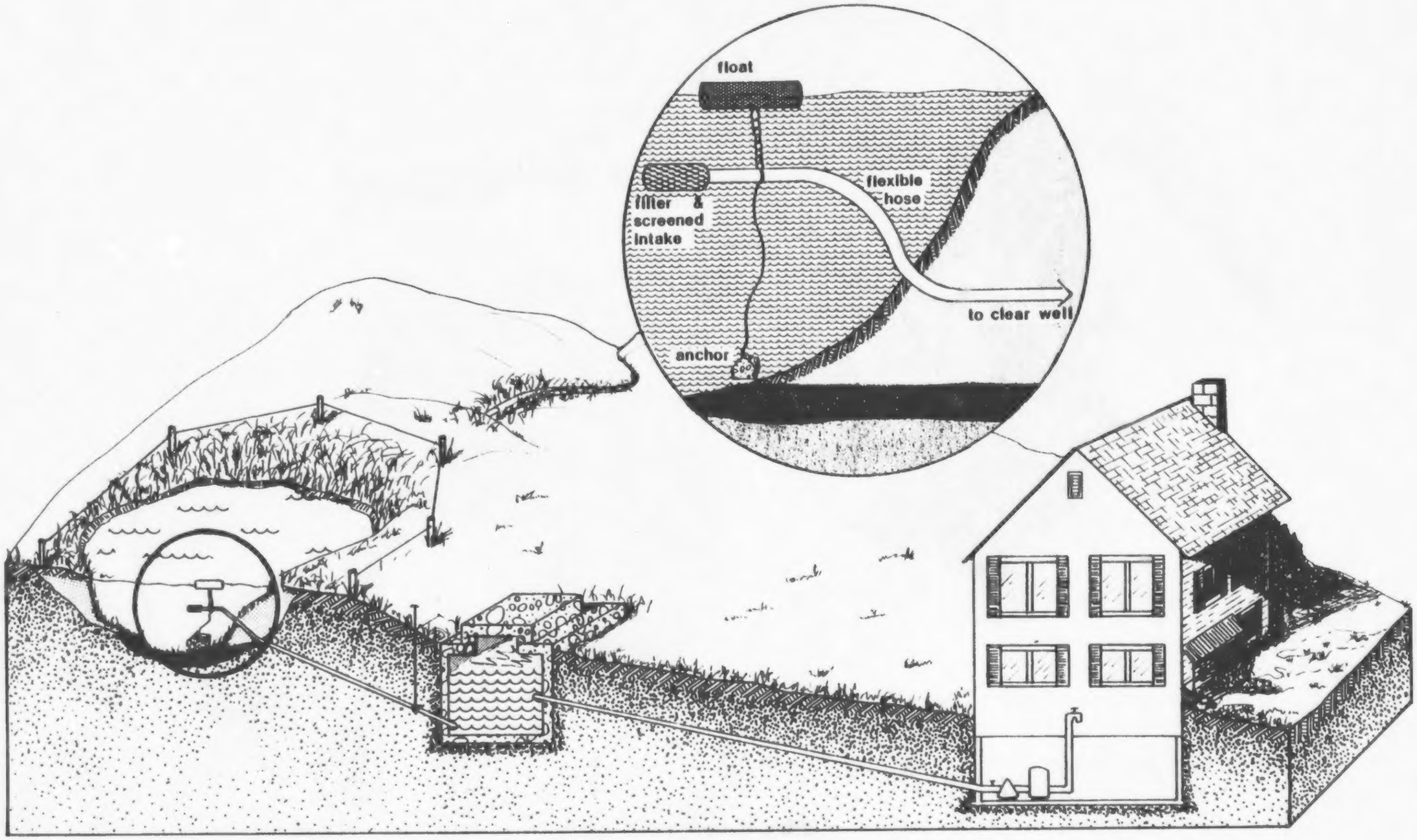
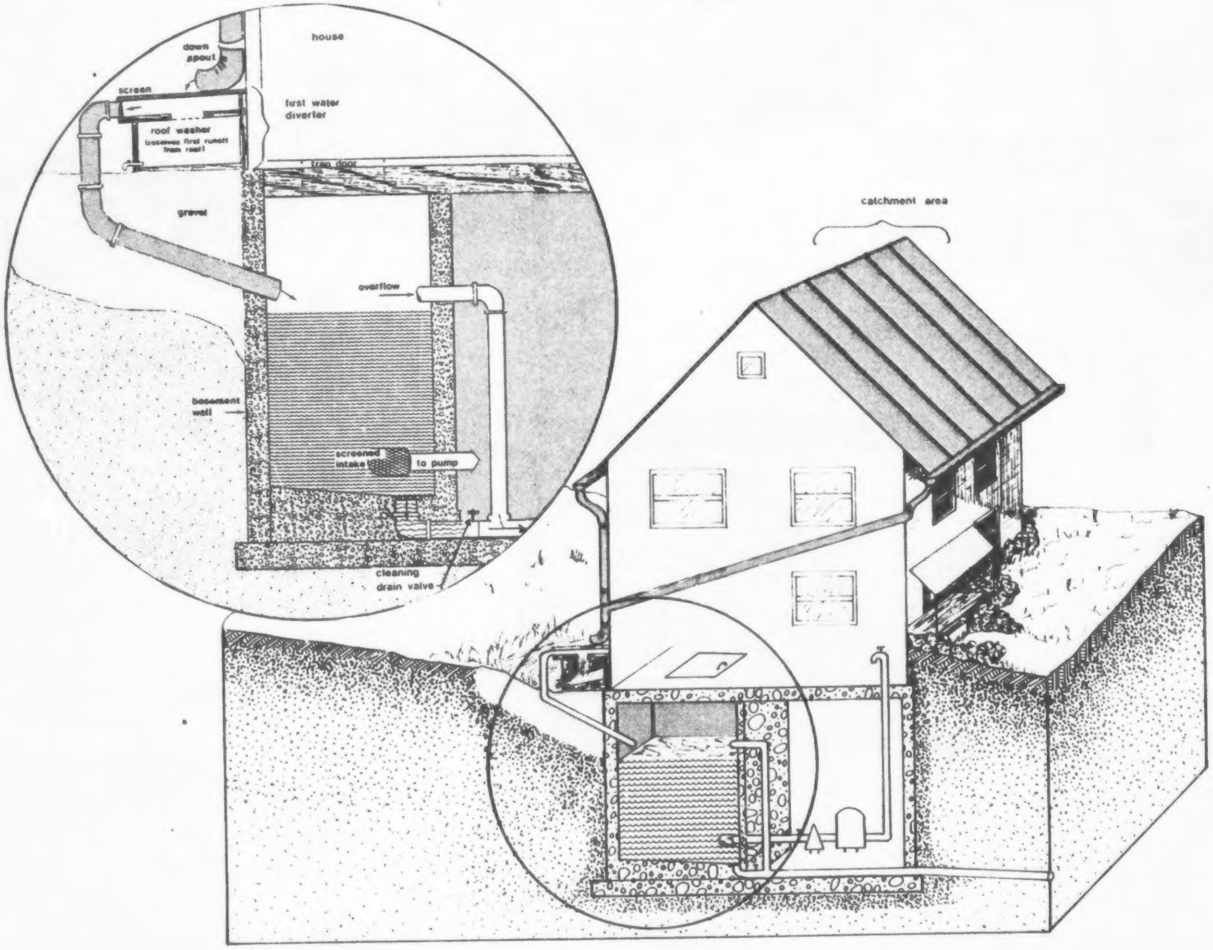

float
filter & screened intake
flexible hose
to clear well
anchor

Figure IV-5
Cistern Supply


down spout
house
screen
first water diverter
roof washer
(receives first runoff from roof)
trap door
gravel
overflow
basement wall
screened intake
to pump
cleaning drain valve
catchment area

DRINKING WATER SUPPLIES

The NSA was designed to determine first of all the type of water supply used for drinking at rural households, how many households had multiple supplies for drinking, and—if there were multiple drinking water supplies—which one served as the major drinking water supply. Community supplies were the most common type of drinking water supply in the rural US. In fact, 10.8 million rural households (49.2 percent) obtained drinking water from a community supply. Well supplies provided drinking water to 9.6 million households (43.6 percent). Together, these two types of supplies furnished drinking water to almost all rural households—20.4 million out of 22 million. Only 3.5 percent of rural households used hauled water; 2.6 percent used purchased bottled water, and 2.3 percent used spring supplies. Surface water and cistern supplies were each used for drinking water at 0.6 percent of rural households (see Figure IV-6).

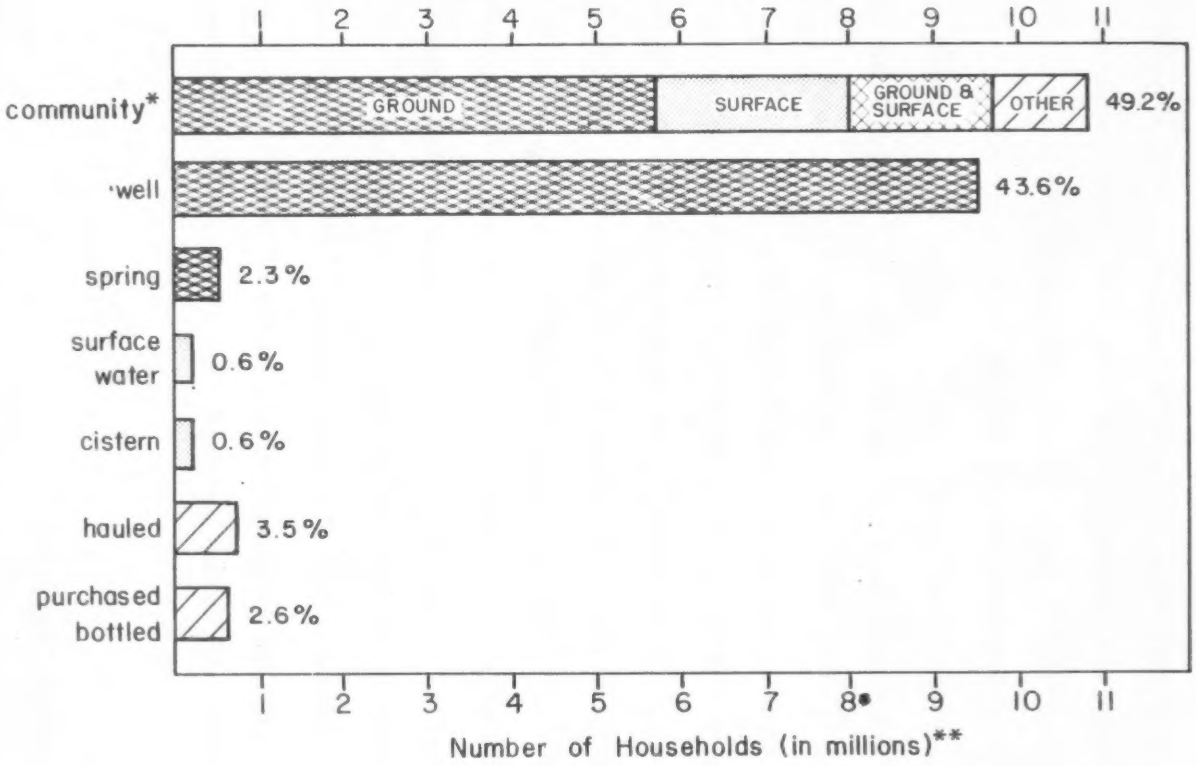
The current predominance of community supplies in rural America highlights a trend which has accompanied the urbanization of the US. In 1970, for example, nearly 55 percent of all households in rural areas were supplied by water from individual wells.[1] That percentage had dropped more than ten points by the time of the NSA survey. In contrast, only about 38 percent of rural households in 1970 were served by private or public water companies—roughly equivalent to community supplies in the NSA. By the time of the NSA survey, this percentage had risen more than ten points. The overall proportion of other supplies—springs, surface water, cisterns, hauled water, and purchased bottled water, combined—rose only slightly, from about 7 percent in 1970 to 9.6 percent at the time of the NSA study.

Multiple drinking water supplies

Most households in the rural US obtained drinking water from only one supply. However, 2.2 percent, or roughly 494,000 households, had a second supply

Figure IV-6

Types of Rural Drinking Water Supplies



*shaded areas designate number of households on community supplies with respect to sources of water.

**the total of the percentages exceeds 100% because some households have more than one drinking water supply.

of drinking water. Unless such a household secured equal quantities from each supply or used both supplies with the same frequency, one of the supplies necessarily was the household's primary or major drinking water supply, while the other was a supplement.

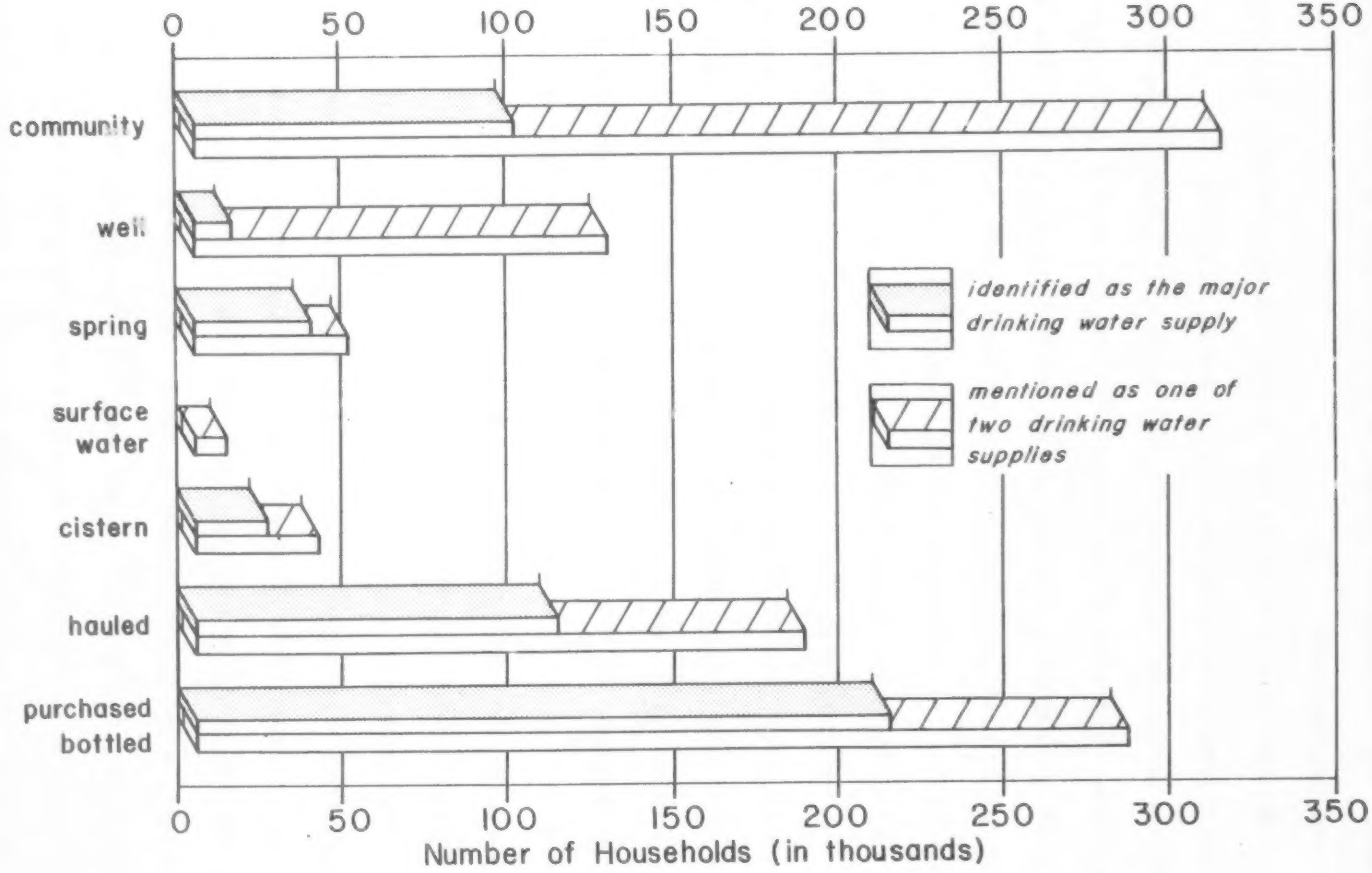
Multiple drinking water supplies tended to consist of some combination of community supplies, wells, hauled water, or purchased bottled water. That is, the households tended to be served by two different supplies among these four possibilities. On the other hand, springs, cisterns, and surface water supplies did not appear frequently in combination with each other or with any other supply. Considering that each two-supply combination theoretically could have consisted of any two of the seven different systems, a variety of combinations were possible; nevertheless, only a few combinations were prevalent in rural America.

In the approximately 494,000 households with two drinking water supplies, it was most likely that one of the supplies was a community supply, but that the second supply was the preferred (major) drinking water supply. Purchased bottled water or hauled water were most likely to be the second supply, the one used most often for drinking. While they were not as prominent overall, households with wells were even more likely to satisfy most of their drinking water demand with another type of supply. Generally, hauled water was the major supply of drinking water for multiple-supply households with wells.

The tendency, in this context, for community water supplies and wells to be supplements to purchased bottled or hauled supplies can be better illustrated by referring to Figure IV-7. Of the 312,000 households that mentioned community water supplies as one of two from which the household obtained drinking water, only 97,000, or 31.1 percent, used a community supply as the major supply of drinking water. Similarly, while wells were mentioned as one of two supplies by 126,000 households, only 13,000, or 10.3 percent, identified a well as the major drinking water supply. In contrast, however, 190,000 households mentioned hauled

Figure IV-7

Types of Supplies for Rural Households with Multiple Drinking Water Supplies



water as one of two drinking water supplies, and 117,000 households, or 61.6 percent, designated hauled water as the supply used most often for drinking. Also, while 276,000 households identified a purchased bottled supply as one of two drinking water supplies, 209,000 households, or 75.7 percent, used a purchased bottled supply for the majority of their drinking water requirements.

Although there were several possible explanations for a household having multiple drinking water supplies, reasons given in the majority of households were related to some aspect of the supply that was used less often for drinking. The most common reason for having a second drinking water supply—the reason mentioned at about 279,000 households (56.5 percent of those with multiple drinking water supplies)—was that the water provided by the other supply was not good enough in quality to drink. This was particularly true if the major drinking water supply was hauled or purchased bottled water. Other households had multiple drinking water supplies because obtaining water from one of the supplies was too costly, or because one supply—regardless of its type—was unreliable. Some households—only about 4 percent—used a second supply to supplement one that did not provide enough drinking water.

Summary, Drinking water supplies and multiple drinking water supplies

Rural households usually had one drinking water supply, most often a community supply (49.2 percent of all rural households). Well supplies, which provided drinking water to 43.6 percent of all rural households, were nearly as common as community water supplies. The prevalence of community supplies in comparison to wells represented a substantial departure from the pattern observed prior to 1975, when wells were the predominant type of drinking water supply.

A small percentage of rural American households (2.2 percent) had multiple drinking water supplies—most frequently a combination of a community supply and purchased bottled water. The major drinking water supply at households with multiple drinking water supplies most often was purchased bottled water, followed in frequency by hauled water. Prominent explanations for having a second supply included the better quality of the water provided by the major drinking water supply and the cost of one of the supplies.

Subnational variation in drinking water supplies

While the community supply was the most common type of drinking water supply in the nation as a whole, the Northeast and North Central regions departed from that pattern. As shown in Table IV-1, the number of households that used a well for a drinking water supply exceeded the number that used a community supply in both regions. In the North Central, where wells occurred most frequently, 59.0 percent of households had wells as drinking water supplies, while in the Northeast around 47 percent of households obtained drinking water from wells.

The prevalence of wells in these regions coincides with certain aspects of their geology. For example, the North Central and Northeast are characterized by glacial sediments and by limestone and sandstone. These formations provide an extensive bank of relatively shallow water sufficient to supply domestic wells. This source of water is periodically replenished by the substantial average rainfall in the regions. This area also includes the hills and valleys of the Appalachians, which are conducive to numerous small springs. Indeed, the highest incidence of spring supplies occurred in the Northeast, where springs comprised 5.2 percent of household drinking water supplies.

In contrast to the Northeast and North Central regions, only about one-third of the households in the West and South relied on wells for drinking water. Community supplies constituted the predominant type of drinking water supply for households in these regions, comprising about 62 percent of the supplies in the West and roughly 56 percent of those in the South. As to associated geological conditions, the depth of underlying aquifers hinders development of wells in the

Table IV-1

Regional Differences in Types of Rural Drinking Water Supplies

Type of Supply	Number and Percent of Supplies				
	Nation	Northeast	North Central	South	West
Community	10,801,000	1,618,000	2,285,000	5,188,000	1,711,000
	49.2%*	43.8%	36.8%	55.8%	61.6%
Well	9,570,000	1,723,000	3,663,000	3,413,000	771,000
	43.6%	46.7%	59.0%	36.7%	27.8%
Spring	516,000	191,000	17,000	265,000	43,000
	2.3%	5.2%	0.3%	2.9%	1.5%
Surface water	129,000	30,000	6,000	22,000	70,000
	0.6%	0.8%	0.1%	0.2%	2.5%
Cistern	134,000	20,000	29,000	85,000	0**
	0.6%	0.5%	0.5%	0.9%	0.0%
Hauled	758,000	198,000	153,000	355,000	53,000
	3.5%	5.4%	2.5%	3.8%	1.9%
Purchased bottled	578,000	37,000	91,000	145,000	305,000
	2.6%	1.0%	1.5%	1.6%	11.0%
Total	22,486,000	3,817,000	6,244,000	9,471,000	2,953,000

*The base for the percentages was either the number of rural households in the nation or the number of rural households in each region. Since some households had more than one drinking water supply, the percentages in each column total to more than 100 percent and are therefore not reported.

**Although some households in the West presumably obtained drinking water from cisterns, the fact that none were included in the NSA sample indicates that this was a very uncommon situation in the West.

Each figure in the table is rounded independently; numbers and percentages may not equal rounded totals.

West. Abundant, easily reached groundwater in the South favors use of wells, but the shift in that region from individual wells toward community supplies is consistent with recent population-associated trends.

It is important to note that purchased bottled water was the drinking water supply for fewer than 2 percent of rural households in all regions except the West. There, 11.0 percent of rural households used purchased bottled water. This situation, in conjunction with the fact that the majority of households in the West used community supplies, contributed heavily to the national estimate of the number of households with multiple drinking water supplies where purchased bottled water was preferred over water provided by community supplies. Water is relatively scarce throughout the West, compared to the Northeast and North Central regions; consequently, most households in the West rely upon large community supplies for their drinking water. However, if the community supply's water is demonstrated or perceived to be somehow inadequate for drinking, commercially distributed water is the most feasible alternative, given the lesser availability of water in the region. This pattern in the West was so pronounced that it dominated the national estimate of the number of purchased bottled drinking water supplies.

The accuracy of the preceding analysis was confirmed to some extent by examining the reasons for having multiple drinking water supplies and taking into consideration the region in which the household was located. In the Northeast, where low-production wells predominate, the quantity of the water obtained from the supplementary drinking water supply was a relatively important factor in explaining the presence of a second supply even though the quality of the supplementary drinking water supply was more significant. Quantity was not a major reason cited by households in any other region, which was consistent with expectations derived from knowledge of each region's configuration of supplies and their characteristic features. In the South and North Central, the most frequent explanation for having multiple supplies was also the quality of the supplementary drinking water supply, while in the West the expense of acquiring water from one of the supplies was the most prevalent reason.

While drinking water in the West is more costly than in other regions (see Chapter V), this pattern of variation was judged to be primarily a result of differing orientations to the question on reasons for having multiple drinking water supplies. The basis for this conclusion was that households in the West typically were using the more expensive supply for drinking even though an alternative drinking water supply was reported to be available. This suggested that these households preferred to use either a purchased bottled or hauled supply exclusively, but that to do so would have been too costly. Therefore, in these households, the expense of the purchased bottled or hauled supply, rather than the cost of the other household supply, was the reason for having more than one supply of drinking water.

Although the cost of water appeared to be a prominent reason for having a second drinking water supply in the West, the insufficient quality and availability of either household drinking water supply was also noted by substantial proportions of households in that region. Aside from these findings, perhaps the most striking aspect of the examination of reasons for having two drinking water supplies was that 83.7 percent of the households in the South with multiple drinking water supplies signified that it was one supply's inferior quality that caused them to have an auxiliary supply of drinking water. In the South, just as in the West, the motivation to use another water supply usually involved some feature of a community supply, such as the quality of its water or supply interruptions.

On the basis of this information, one might have supposed that a larger proportion of households in the West and South would have multiple drinking water supplies. Indeed, as expected, the West showed the greatest proportion of households with two drinking water supplies—6.3 percent. But the proportion in the Northeast—3.2 percent—was higher than expected, since it exceeded the proportion in the South. About 2 percent of the rural households located in the South had more than one drinking water supply, while in the North Central the comparable proportion was less than 1 percent.

To summarize, community supplies conveyed drinking water to larger proportions of households in the West and South (61.6 percent and 55.8 percent, respectively). Wells were more common in the North Central and Northeast, where 59.0 percent and 46.7 percent of households, respectively, used that type of drinking water supply. In proportional terms, more households in the Northeast used hauled water (5.4 percent) and springs (5.2 percent) as drinking water supplies than did households in the other three regions. Also, purchased bottled supplies tended to be much more prevalent in the West, where they provided drinking water to 11.0 percent of households.

In addition to differences by region, some less pronounced differences in the pattern of drinking water supplies occurred among rural households according to whether or not a household was located within the boundaries of an SMSA. Approximately 58 percent of all SMSA households used a community supply as a supply of drinking water, while only 45 percent of those outside of SMSAs acquired drinking water from a community supply. In areas outside of SMSAs, the most prevalent type of supply was a well, with 46.7 percent of all nonSMSA households using wells. Also, in proportional terms, more SMSA households than nonSMSA households purchased their drinking water from a commercial distributor, while more nonSMSA households obtained drinking water from a spring or by hauling. There were at most only slight differences in the percentages of households using surface water supplies or cisterns.

As would be expected given SMSA/nonSMSA differences, drinking water supplies also varied according to whether a household was located in a large rural community, small rural community, or other rural area. In large communities, 91.8

percent of the households used a community supply for drinking, and most of the remaining households (6.2 percent) used wells. In small communities, 80.4 percent of households were connected to community supplies, and 15.8 percent used wells. As was anticipated, the availability of community supplies was limited in other rural areas. Only 41.0 percent of households in other rural areas used community supplies for drinking, and 50.8 percent used wells. Households in other rural areas were eight times as likely to have a well for drinking water as households in large rural communities.

To put this difference into perspective, it should be remembered from Chapter II that most rural households are located outside of established communities—that is, in other rural areas. Of the approximately 22 million households in the rural US, about eighteen million (81.8 percent) were located in other rural areas, while the remaining four million (18.2 percent) were located in communities of varying sizes. Given these proportions, the types of water supplies should be similarly distributed, unless there is some aspect of communities or other rural areas that would make a certain supply more prevalent. Therefore, of the approximately 9.6 million households that used wells for drinking water, almost 9.2 million (95.8 percent) were located in other rural areas. Similarly, 1.3 million (86.7 percent) of the 1.5 million households which used cisterns, hauled water, or purchased bottled water as a drinking water supply were located in other rural areas. On the other hand, only about 7.2 million (66.7 percent) of the 10.8 million households that used community supplies for drinking water were located in other rural areas. Once again, this pattern largely reflected the tendency of households in other rural areas to obtain drinking water from types of supplies other than a community supply, as was suggested in the preceding paragraph. A possible reason for the higher incidence of these other types of supplies is that other rural areas typically do not have the population concentrations that are necessary to support community supplies. Since they do not have access to community supplies, households in other rural areas tend to secure their drinking water from wells.

Special consideration of hauled drinking water supplies

The importance of hauled water as a drinking water supply was difficult to evaluate from the preceding information. Although about 3.5 percent of all supplies that provided drinking water to rural households consisted of hauled water, only in about 3.1 percent of all rural households was a hauled water supply used most often for drinking. In 17.0 percent of these 686,000 households, hauled water was one of two drinking water supplies, while in the other 83.0 percent (570,000 households), hauled water was the only drinking water supply. Likewise, about 733,000 households had at least one supply of hauled drinking water. However insignificant these findings appear to be relative to the drinking water situations of the great majority of rural households, the fact remains that a substantial number of rural households depended upon a very inconvenient and potentially expensive supply of drinking water. While other information would have been too difficult to obtain, the NSA did directly investigate the reasons for hauling water, how frequently each month hauling occurred, and how much water was hauled at a time.

The most common explanation for hauling water was that the quality of the water from another household supply was considered inadequate for drinking. This was reported by about 41 percent of the 733,000 households that had at least one hauled drinking water supply (301,000). Other prevalent reasons included the absence of another drinking water supply (33.3 percent, or 244,000) and the healthfulness of the hauled water in comparison to that available from the other supply (16.4 percent, or 120,000). (In this context, and in this report as a whole, healthfulness was interpreted to mean that the water had a beneficial rather than a negative effect on one's health.) By comparison, the intermittent availability of the other supply or the insufficient quantity of water that it provided were factors in the decision to use hauled water at only 4.5 percent (33,000) and 0.8 percent (6,000) of the households, respectively.

The frequency with which water was hauled varied substantially among households with hauled drinking water supplies. Some households hauled water as many as 90 times or more each month, while other rural households hauled water no more often than once monthly. Between these extremes, 37.2 percent of the 733,000 households with at least one hauled drinking water supply (273,000) hauled water four times or less each month, and 15.5 percent (114,000) hauled water from nine through twelve times monthly (see Table IV-2). The median frequency of hauling was about 7.7 times per month. Although it is not conveyed directly by the table, the largest proportion of households (22.3 percent) hauled water four times a month, or once a week. Variations in hauling frequency were thought to result from several factors, including the capacity of the household's water storage facilities, accessibility of the source of the hauled supply, and the mode of transport.

The quantity of water that was hauled at any one time also varied appreciably among households. About 25 percent of the households (180,000) hauled ten liters (three gallons) or less, and 24.2 percent of the households (177,000) hauled from eleven liters (three gallons) through nineteen liters (five gallons). Another 24.2 percent (177,000) hauled from 21 liters (six gallons) through 40 liters (eleven gallons) on each occasion, and 18 percent of the households (132,000) hauled more than 90 liters (24 gallons). The largest quantity obtained by hauling was about 3,800 liters, or about 1,000 gallons. To put this quantity into perspective, 1,000 gallons would be sufficient to provide for the typical domestic needs of a three-person household for five to eight days. This estimate is based on an average consumption rate of 40 to 70 gallons per person per day in a private home, assuming that the household has a pressurized water supply.[2] These differences in the amount of water hauled by households were possibly attributable

Table IV-2

Frequency of Hauling Among Households with Hauled Drinking Water Supplies

Times/Month	Households Number	 Percent	Cumulative Percent
1 - 4	273,000	37.2	37.2
4 - 8	103,000	14.0	51.2
9 - 12	114,000	15.5	66.7
12 - 16	66,000	9.0	75.7
16 - 30	103,000	14.1	89.8
More than 30	75,000	10.2	100.0
*Total	733,000	100.0	

*Includes only households with at least one hauled drinking water supply.

Each figure in the table is rounded independently; numbers and percentages may not equal rounded totals.

to dissimilar water requirements, the frequency of hauling, and a greater—for many households, exclusive—dependence upon the hauled supply.

By combining information on the quantity hauled each time and the number of times that water was hauled each month, it was possible to develop an estimate of the monthly amount of water hauled by each household. Although the smallest quantity hauled was about eight liters (two gallons) per month, and the largest was in excess of 27,000 liters (7,124 gallons), the median quantity hauled was 228 liters (60 gallons). About 47 percent of the households (345,000) hauled 200 liters (53 gallons) or less per month; roughly 37 percent (271,000) hauled between 200 and 1,000 liters (264 gallons); and around 16 percent (117,000) hauled 1,000 liters or more. Even though some households hauled substantial quantities of water, fewer than 1 percent hauled enough water to satisfy the average water requirements of a three-person household at the per capita consumption level cited above. However striking this may seem, it was interpreted cautiously since in about 60 percent of these households, the hauled supply was not the major household supply. Therefore, the expectation was that households generally hauled smaller quantities of water because most of them were using it primarily for drinking rather than for other domestic uses such as washing dishes and clothes.

In summary, 733,000 rural households had at least one hauled water supply that was used for drinking. Of these households, roughly 41 percent hauled drinking water because water from the other household supply was determined to be inadequate for drinking, and 33.3 percent did so because they did not have another drinking water supply. Although certain households hauled water as many as 90 times each month, the majority hauled drinking water no more often than eight times each month, or twice a week. Similarly, the median quantity hauled on each occasion was around twenty liters (five gallons), and half the households hauled more than 228 liters (60 gallons) monthly. While these quantities may seem small by some standards, only about 40 percent of these households used hauled water to satisfy requirements other than for drinking water.

Special consideration of purchased bottled drinking water supplies

Similar to the situation for hauled water supplies, purchased bottled water supplies were used as drinking water supplies by only a small proportion of rural households. Only 2.6 percent of all rural drinking water supplies consisted of purchased bottled water, and in only 2.3 percent of all rural households was purchased bottled water considered to be the supply used most often for drinking. While purchased bottled water was one of two drinking water supplies in about 41 percent of those approximately 500,000 households, it was the only supply of drinking water for about 300,000 households.

However uncommon purchased bottled drinking water supplies were estimated to be, they received special attention in the NSA because they represented an unusual supply situation. Also, even though people often used purchased bottled water as a result of perceived or actual shortcomings and potential hazards of alternative supplies, the most recent study of the industry identified deficiencies in surveillance, facilities and their operation, and plant quality control.[3] Therefore, many rural households' reliance on purchased bottled water on the assumption that it is superior to the water available from other supplies may be unjustified. Based on these considerations, the NSA sought additional information from households that used purchased bottled drinking water. It asked about the reasons for using purchased bottled water, the type of commercial establishment from which it was bought, the frequency of purchases, and the quantity obtained.

The majority of households that used purchased bottled water for drinking did so because of the quality of the water provided by the other drinking water supply. About 49 percent of the 545,000 households that had at least one purchased bottled drinking water supply (267,000) reported that the other supply's water was judged not good enough in quality to drink, while another 33.6 percent (183,000) noted that the purchased bottled water was more healthful than the water in the second supply. Another 13.0 percent of the households (71,000) used purchased bottled water because no other source of water was available at the house. Only about 5 percent (27,000) cited the inadequate quantity of water from the other supply as a reason for drinking purchased bottled water.

About 70 percent of all households that used purchased bottled water for drinking (382,000) acquired it from a grocery store. Approximately 27 percent of the households (147,000) bought purchased bottled water from a retail water distributor, while another 3.6 percent (19,000) obtained the purchased bottled water from some other type of commercial establishment.

According to Table IV-3, which presents information on the frequency with which water was acquired by the 545,000 households using purchased bottled water for drinking, the largest proportion of households (34.2 percent, or 186,000) purchased water once a month. While the remaining 65.8 percent bought purchased bottled water more frequently than once a month, only 1.6 percent (9,000) purchased it more often than eight times a month, or twice each week. Also, though not precisely stated in the table, slightly more than 24 percent of the households bought water once a week, or four times monthly. The median number of times that water was purchased was about 3.3 times each month, and the maximum was twelve, or around three times weekly.

Corresponding to the finding that the majority of households bought purchased bottled water from a grocery store, most households acquired relatively small quantities at a time. Cumulatively, about 54 percent of the households (294,000) bought less than twenty liters (five gallons) of purchased bottled water at a time, and about 77 percent (420,000) purchased 40 liters (eleven gallons) or less. The smallest quantity purchased by any household was approximately four liters (a gallon), while the largest quantity purchased was 7,800 liters (2,058 gallons).

Table IV-3

Frequency of Purchasing Water Among Households with Purchased Bottled Drinking Water Supplies

Times/Month	Households Number	Households Percent	Cumulative Percent
1	186,000	34.2	34.2
2 - 3	96,000	17.6	51.8
4 - 6	140,000	25.7	77.5
7 - 8	114,000	20.9	98.4
More than 8	9,000	1.6	100.0
*Total	545,000	100.0	

*Includes only households with at least one purchased bottled drinking water supply.

Each figure in the table is rounded independently; numbers and percentages may not equal rounded totals.

Although small quantities were most common, a substantial proportion of the households (about 14 percent) purchased water in amounts greater than 3,000 liters (792 gallons). This was not particularly unexpected, given the proportion of households that bought bottled water from bulk distributors.

Considering that purchased bottled water is typically more expensive than water from other types of supplies, surprisingly large quantities of water were bought each month by some households. Approximately 6 percent of households (33,000) bought purchased bottled water in quantities greater than 15,000 liters (3,958 gallons), while another 10 percent (54,000) purchased from 3,000 through 15,000 liters (792 gallons) monthly. In most instances, these households purchased larger quantities of bottled water because they did not have access to an alternative supply. When a supplementary supply was available, which was the case for most of the households that used purchased bottled water for drinking, a smaller amount of bottled water was obtained. This was confirmed by the finding that, cumulatively, about 70 percent of the households (382,000) bought less than 100 liters (26 gallons) per month, about 50 percent (272,000) purchased less than 65 liters (seventeen gallons), and about 30 percent (164,000) bought less than 30 liters (eight gallons) per month. Certainly, in these households, purchased bottled water was employed to satisfy what some might consider to be minimal drinking water requirements. In contrast to households that had hauled supplies of drinking water, where the median was 228 liters (60 gallons) per month, the median quantity of water purchased by households that used bottled water was only about 64 liters (seventeen gallons) per month.

To summarize, purchased bottled supplies provided drinking water to 545,000 rural households. The two most common reasons for drinking purchased bottled water were that the quality of the water available from another supply was not thought good enough to drink (48.7 percent), and that the water from the purchased bottled supply was more healthful (33.6 percent). The majority of households (69.6 percent) acquired purchased bottled water from a grocery store no more often than three times each month (51.8 percent). Although the quantity purchased on each occasion varied, roughly 54 percent of the households bought less than twenty liters or five gallons at a time. When compiled for an entire month, the median quantity bought by these households was 228 liters (60 gallons).

MAJOR HOUSEHOLD WATER SUPPLIES

Although a central objective of the NSA was to describe rural households' drinking water supplies, it was apparent that a study of drinking water supplies in isolation from the supplies that served most domestic needs for water would not be satisfactory. One reason was that drinking water comprises only a small part of the total amount of water used in a household. Just as important was that a research focus on drinking water supplies alone would preempt questions about why some major household water supplies—those that met most domestic needs—were not used for drinking. As a result of these concerns, the scope of the NSA included domestic water supplies that were used for normal household needs such as cooking, bathing, and cleaning, as well as for drinking. These supplies, called major household supplies in the NSA, are the primary subject of this section of Chapter IV, and are the focus of most subsequent material about supplies, systems, and sources.

All but 3 percent of rural households had only one water supply, so that the drinking water supply was identical to the major household supply. In the 3 percent of households with more than one supply, the respondent identified the one that was the major household supply.

About eleven million rural households (50.0 percent) used a community supply as their major water supply. Wells, supplying 9.8 million rural households (44.8 percent), were the second most common type of major water supply. Only 489,000 households (2.2 percent) used a spring as the major supply, and 269,000 (1.2

percent) used hauled water as the major supply. Other types of supplies were each used by less than 1 percent of rural households (see Table IV-4).

The close correspondence between drinking water supplies and major household water supplies can be seen in a comparison of Tables IV-1 and IV-4. Slightly more households used community supplies and wells as their major household supply, as opposed to their drinking water supply, while slightly fewer households used hauled or purchased bottled water. Overall, the correspondence is very strong because so few rural households had multiple drinking water supplies and because the major water supply was the same as the drinking water supply (or the supply used most often for drinking) at 97 percent of all rural households.

Contrasts between Tables IV-1 and IV-4 also illustrated the tendency for hauled and purchased bottled supplies to occur as supplements to community supplies or wells not considered suitable for drinking. About 758,000 households nationally used hauled water as a drinking water supply, but only 269,000 households satisfied most of their needs with hauled water. Likewise, while approximately 578,000 households obtained drinking water from a commercial distributor, only about 102,000 households designated that as their major supply.

About 900,000 rural households had a drinking water supply that was not the major water supply. (Usually, this meant that the drinking water supply could not meet the household's other needs for water.) About 92 percent of these households used either hauled or purchased bottled water for drinking; the rest obtained drinking water from either wells or springs. None of these households used community supplies, surface water supplies, or cisterns for drinking.

Summary, Major household water supplies

A community supply was the major water supply in 50.0 percent of all rural households. Wells, which were used by about 45 percent of all rural households, were second most prominent. While only 2.2 percent of households used springs as

Table IV-4
Major Rural Household Supplies

Type of Supply	Nation Number of Households	Percent of Households
Community	10,981,000	50.0
Well	9,850,000	44.8
Spring	489,000	2.2
Surface water	141,000	0.6
Cistern	142,000	0.6
Hauled	269,000	1.2
Purchased bottled	102,000	0.5
Total	21,974,000	99.9

Each figure in the table is rounded independently; numbers and percentages may not equal rounded totals.

a major supply, even smaller proportions had any of the other types. In 97.0 percent of all rural households, the major supply provided drinking water in addition to satisfying other domestic water requirements. The other 3.0 percent of households obtained drinking water from a supplement to the major supply, and the supplementary supply tended to be either hauled or purchased bottled water.

Subnational variation in major household supplies

Table IV-5 displays the regional variation in major household supplies. Generally, the pattern corresponded very closely to the variation in drinking water supplies (presented in Table IV-1). Community supplies were the major household supply for most rural households located in the South and West, but wells were the predominant major supply for households in the Northeast and North Central. The North Central had the largest proportion of households which used wells as major supplies (60.7 percent), while in the Northeast roughly 49 percent of households had wells as their major supply. In the South and West, wells were substantially less prevalent, and community supplies were much more prevalent. Approximately 66 percent of all households in the West used a community supply as the major supply. This proportion was appreciably higher than in the other three regions. In the South, 56.5 percent of households had a community supply as the major supply (a proportion noticeably higher than the national estimate of 50.0 percent). Together, community supplies and wells constituted the major supply for 97.4 percent of rural households in the North Central, 95.5 percent of rural households in the West, 93.7 percent of rural households in the South, and 92.6 percent of rural households in the Northeast.

Except for springs, which provided water to a larger proportion of rural households in the Northeast (5.0 percent), there was little variation among regions in the frequencies of the remaining types of major supplies. When springs were excluded, the combined proportions of households that had major supplies

Table IV-5

Regional Variation in Major Rural Household Water Supplies

	Number and Percent of Households			
Type of Supply	Northeast	North Central	South	West
Community	1,608,000	2,280,000	5,249,000	1,844,000
	43.5%	36.7%	56.5%	66.4%
Well	1,815,000	3,769,000	3,458,000	808,000
	49.1%	60.7%	37.2%	29.1%
Spring	185,000	12,000	258,000	34,000
	5.0%	0.2%	2.8%	1.2%
Surface water	30,000	17,000	29,000	64,000
	0.8%	0.3%	0.3%	2.3%
Cistern	20,000	29,000	92,000	0*
	0.6%	0.5%	1.0%	0.0%
Hauled	18,000	43,000	181,000	27,000
	0.5%	0.7%	1.9%	1.0%
Purchased bottled	17,000	62,000	23,000	0*
	0.5%	1.0%	0.2%	0.0%
Total	3,693,000	6,213,000	9,291,000	2,777,000
	100.0%	100.1%	99.9%	100.0%

*No household sampled in the West used a cistern or purchased bottled water as the major household water supply.

Each figure in the table is rounded independently; numbers and percentages may not equal rounded totals.

consisting of surface water, cisterns, and hauled or purchased bottled water ranged from a high of 3.4 percent in the South and West to a low of 2.5 percent in the North Central. As explained earlier in this chapter, the regional variation in the frequency of each type of major household supply was largely attributable to unique aspects of geology. Those geological features determined the relative abundance and availability of certain forms of source water.

Although only tangentially related to the regional variation in major household supplies, it is interesting that the NSA sample included no households in the West that used purchased bottled water as a major supply, though about 300,000 rural households there used purchased bottled water for drinking. Implicitly, this supported the suggestion that purchased bottled water was used primarily to supplement a supply that was not satisfactory for drinking. Though this pattern was most conspicuous in the West, it was also detected in the other three regions.

SMSA/nonSMSA differences with regard to major household supplies paralleled differences in drinking water supplies. Within SMSAs, about 60 percent of households used a community supply as the major supply, while only about 38 percent used wells. Outside of SMSAs, on the other hand, the proportion of households using a community supply as the major supply was only slightly greater than 45 percent, and about 48 percent used wells. In other words, major water supplies consisted of either a community supply or a well in roughly 97 percent of SMSA households, compared to about 94 percent of nonSMSA households. The proportion of SMSA households that used springs, cisterns, surface water, hauled water, or purchased bottled water as the major supply was about 3 percent, compared to about 6 percent of nonSMSA households.

Besides SMSA/nonSMSA differences, somewhat different patterns were seen in the size-of-place comparison. Specifically, in large rural communities, 93.5 percent of households had a community supply as their major supply. Wells were used as the major household water supply by approximately 6 percent of households in large communities. Since 99.5 percent of households in large rural communities had community supplies or wells as a major water supply, only 0.5 percent used springs, surface water supplies, cisterns, hauled, or purchased bottled water.

In small rural communities, wells were somewhat more common, but community supplies still predominated. Slightly less than 83 percent of households in small rural communities used a community supply, while about 16 percent used a well. Springs and hauled water were the major supplies of the other households located in small communities (1 percent, combined).

Other rural areas showed a much different pattern of major water supplies than that seen in large and small rural communities. In other rural areas, wells were the most common major supply, and community supplies were second most common. Approximately 52 percent of households in other rural areas used a well as the major water supply, while only about 42 percent used a community supply. Major water supplies for the remaining 6.0 percent of households in other rural areas were, in order of their frequency, springs, hauled water, surface water, cisterns, and purchased bottled water.

Special consideration of hauled major water supplies

Although hauled water was the major supply for only an estimated 269,000 rural households across the country, most of these households apparently did not have access to a satisfactory alternative. Other supplies of water were either completely unavailable, too costly to develop, or incapable of meeting the household's demand for water. In these households, acquiring water doubtless entailed considerable inconvenience. Sometimes, this might have meant an allocation of time that could have been better spent in other activities; more often, a household probably was compelled to adjust its pattern of living to the conditions imposed upon it by its water supply situation. Adjustments might include rationing of water; restricted bathing, washing, and grooming; or more severe forms of deprivation. Since the potential qualitative significance of hauled major water supplies could be far greater than their numbers might suggest, special consideration was given to households with these supplies. As for hauled drinking water supplies, information was compiled on the reasons for having a hauled supply, the frequency of hauling, and the quantity hauled.

Of the 269,000 households that used hauled water as their major water supply, about 76 percent, or 204,000 households, did so because no other supply was available to them. Another 14.0 percent, or 38,000, hauled water because another household supply did not produce water that was good enough to drink. The only other reason that was expressed at more than 5 percent of these households (13,000) was that, although alternative supplies were available, they provided water only intermittently. Reasons given by fewer than 2 percent of households using hauled water as the major household supply included the inability of another supply to produce enough water, and the healthfulness of the water from the hauled supply.

Information on the frequency of hauling suggested that rural households with hauled major supplies tended to haul water less often than twelve times each month. About 29 percent (78,000) hauled water between one and four times monthly, and about 22 percent (59,000) hauled water between four and twelve times each month. An additional 36.0 percent (97,000) hauled water between twelve and 40 times a month, while about 6 percent (16,000) hauled water from 40 through 89 times monthly. The remaining 6.0 percent—16,000 households—hauled water 90 times a month or more frequently. Clearly, these latter households obtained hauled water from sources that were immediately accessible if not located on the premises. The median number of times that hauling was done each month by these 269,000 households was about twelve.

As was expected, the quantity of water hauled at any one time varied substantially from household to household. Some households hauled water in quantities as small as three liters, which is less than a gallon, while others hauled approximately 3,800 liters (1,003 gallons) at a time. Cumulatively, about 51 percent of the households (137,000) obtained 50 liters (thirteen gallons) or less of hauled water at a time, and roughly 73 percent (196,000) hauled 100 liters (26 gallons) or less. At the other extreme, a little less than 10 percent of the households (27,000) hauled water in quantities over 3,000 liters (791 gallons). The median amount hauled per trip was slightly over 45 liters (twelve gallons).

There was even more variability in the quantity of water hauled each month. The smallest amount hauled per month was fifteen liters (about four gallons), while the largest was over 27,000 liters (roughly 7,120 gallons). Although slightly over 12 percent of the households (32,000) hauled 100 liters (26 gallons) or less each month, around 20 percent (54,000) hauled 2,000 liters (528 gallons) or more. The median quantity hauled each month was 609 liters, or 161 gallons. While this figure may seem unusually low since these households generally had no other water supplies, it indicated the extent to which these households modified their water requirements to adapt to their supply situation.

Summary. As stated earlier, hauled water was the major supply for 269,000 rural households. About 76 percent of these households used hauled water because no other supply was available, while another 14.0 percent hauled water because the quality of another water supply was considered inadequate for drinking. Most households hauled water twelve times each month (or three times weekly), in quantities that did not exceed 50 liters (thirteen gallons) on each occasion. For an entire month, the median quantity hauled was 609 liters, or 161 gallons.

Special consideration of purchased bottled major water supplies

The estimated number of households that had major supplies of purchased bottled water was even smaller than the number of households with hauled water supplies. As reported in Table IV-4, 102,000 rural households used purchased bottled water for most of their domestic needs. Again, however, since the use of these supplies had important implications for the households that depended upon them, they demanded special consideration.

Generally, households using commercially processed water probably incurred higher unit costs for their water than households with other types of major supplies. Moreover, the quality of purchased bottled water has been neither as closely monitored nor as uniformly regulated as commonly thought.[4] The consequence of these two combined factors is that a household using purchased bottled water may have spent more money for water, and may have received water that was inferior to that provided by an alternative supply, assuming that one was available. Of course, when another supply was not available, the household using a purchased bottled supply had no choice but to adapt itself to its supply situation. Unless financial considerations were immaterial, this involved curtailing water consumption or forgoing labor-saving devices which would not have operated properly without large quantities of water. Since some households did rely exclusively on purchased bottled water supplies, the NSA compiled some additional information about them. Presented here are the reasons for having purchased bottled water as a major supply, the type of commercial establishment from which the water was bought, the frequency of water purchases, and the quantity that was purchased.

The most common explanation for households using purchased bottled water as their major supply was that no other source was available. This reason was reported in 63.0 percent of the 102,000 households that had purchased bottled water for the major supply (64,000). Another 18.0 percent (18,000) noted that another supply was present but did not provide enough water. An additional 19.0 percent (19,000) attributed the use of the purchased bottled water to the poor quality of another water supply, either by reporting that the quality of the water from the other supply was judged to be inferior (12.6 percent, or 13,000), or by calling attention to the perceived superior healthfulness of the purchased bottled water (6.4 percent, or 65,000).

When purchased bottled water was used as the major household supply, it was most frequently obtained from a retail distributor. About 68 percent of the households (69,000) bought purchased bottled water from this type of establishment, while another 19.0 percent (19,000) acquired the water from a grocery store. In 13.0 percent of the households (13,000), the bottled water was purchased from various other kinds of commercial enterprises.

Most rural households using purchased bottled water as their major household supply bought water no more frequently than once every two weeks, or twice each month. Slightly more than 41 percent of the households (42,000) bought bottled water once every two weeks, while about 20 percent (20,000) bought water once every four weeks. Approximately 33 percent (34,000) purchased their water once a week, and 6.4 percent (7,000) bought bottled water twice each week.

The quantity of bottled water purchased by households on each occasion varied from a minimum of about four liters (one gallon) to a maximum of about 7,800 liters (2,058 gallons). A little more than 30 percent of the households (31,000) purchased 1,000 liters (264 gallons) or less of bottled water each time, while about 19 percent (19,000) acquired 7,000 liters (1,847 gallons) or more each time. The most commonly purchased quantity was 3,790 liters (1,000 gallons), which was reported by about 33 percent of the households using this as their major household supply (34,000). The median quantity purchased was 2,620 liters (691 gallons).

On a monthly basis, the quantity of bottled water purchased ranged from a low of sixteen liters—about four gallons—to a high of 60,640 liters—16,000 gallons. Between these extremes, only 31,000 households, or about 30 percent of households using purchased bottled water as their major supply, bought less than 1,000 liters (264 gallons) each month, while approximately 70 percent (71,000) bought 1,000 liters or more of bottled water per month. The median amount purchased each month was 5,900 liters, or about 1,557 gallons.

Summary. Nationally, only 102,000 rural households used purchased bottled water as the major supply. Usually, purchased bottled water was the major supply because the household did not have access to other supplies (63.0 percent of these households), and the water was obtained from a retail distributor (about 68 percent of these households). Most rural households with purchased bottled major supplies bought water less often than twice each month, or once every two weeks (roughly 61 percent). The median quantity purchased on each occasion and monthly was 2,620 liters (691 gallons) and 5,900 liters (1,557 gallons), respectively.

MAJOR NONDRINKING HOUSEHOLD WATER SUPPLIES

This section focuses on those major household water supplies that were not used for drinking. As reported earlier in this chapter, about 3 percent of all rural households did not use the major supply for drinking. In some instances, the major water supply was reportedly not good enough in quality to drink; in other households, the preference for the alternative supply resulted from other factors. Independent of the reasons for having a supplementary supply, the supplies being considered here were those judged to have been satisfying most household needs even though they were not usually used as drinking water supplies.

Of the approximately 676,000 rural households that obtained drinking water from a supply which was not the major supply, 47.0 percent (318,000) used wells as the major supply, and another 35.0 percent (237,000) used a community supply.

About 6 percent of these households (41,000) used a surface water supply for most of their household needs; 4.3 percent (29,000) and 3.7 percent (25,000), respectively, used purchased bottled water or a cistern. Slightly more than 4 percent of the households (27,000) relied upon springs or hauled water supplies.

When households could not or preferred not to use the major supply for drinking, they tended to obtain drinking water from either a hauled or purchased bottled supply. These two types of supplies provided drinking water to slightly more than 85 percent of the households that did not drink water from the major supply (575,000). While the remaining 14.8 percent (101,000) acquired drinking water from another type of supply, substantially more households (8.4 percent or 57,000) used a well rather than a community supply or a spring.

Subnational variation in major nondrinking household water supplies

Generally, the pattern of variation across regions reflected certain basic similarities between the Northeast, the North Central, and the South. In all three regions, wells were the most common type of major household water supply not used for drinking, while community supplies were second most common. Wells and community supplies constituted about 86 percent of all major household supplies that were not used for drinking in the Northeast, 81 percent of those supplies in the North Central, and 76 percent in the South. The West was unusual in that 94 percent of major water supplies not used for drinking consisted of community supplies and wells, a proportion appreciably higher than was observed in the other regions. In the West, in fact, more than 90 percent of major supplies not used for drinking were community supplies, compared to about 22 percent in the South, 14 percent in the North Central, and 12 percent in the Northeast. Of all regions, the West had the smallest proportion of major nondrinking supplies that were wells (3.5 percent).

Differences also were seen between SMSA and nonSMSA households. Community supplies were the most prevalent type of major nondrinking water supply among SMSA households (60.2 percent), while wells were the most common such supply among nonSMSA households (58.2 percent). These two supply types represented about 90 percent of all major household supplies that were not used for drinking within SMSAs and about 76 percent of those outside of SMSAs. This difference occurred because larger percentages of nonSMSA households satisfied domestic needs other than drinking with springs, surface water supplies, or cisterns.

With some exceptions, the preceding results corresponded to those seen in the size-of-place comparison. Although (unexpectedly) purchased bottled water was the most prevalent type of major water supply not used for drinking among households in large rural communities (61.2 percent), community supplies were the most common for households in small rural communities (85.0 percent). For households in other rural areas, however, wells were the most frequent major water supply not used for drinking (50.4 percent), while community supplies, at 31.5 percent, were second most common. The proportion of households in large communities that had purchased bottled water as a major nondrinking water supply was much greater than anticipated, but that particular result was probably produced by sampling fluctuations and must be interpreted with extreme caution. Only about 19,000 of the 676,000 households that did not drink the major water supply were located in large communities; the remaining 657,000 households were located in small rural communities or other rural areas.

MULTIPLE HOUSEHOLD WATER SUPPLIES

Earlier in this chapter, it was reported that a small proportion of rural households (2.2 percent) had more than one drinking water supply. This estimate did not include household water supplies that were not used for drinking, however, and so did not provide a complete indication of the total number of supplies serving each household or the number of households using multiple water supplies.

Information on the total number of supplies provided a more complete understanding of rural households' supply situations. Typically, when a household had more than one supply, the different supplies supported distinct uses and were consequently more specialized than other supplies. Thus, since households with multiple supplies were less dependent upon one particular water supply, they presumably were less affected by intermittent supply difficulties. Therefore, though one supply was unable to satisfy the household's total demand for water, the combination may have been satisfactory. Offsetting the apparent advantages of multiple supplies was the fact that having a number of supplies entailed greater operating expenses and required more time and energy in maintenance.

Although no rural household had more than two drinking water supplies, a very small proportion of rural households (0.1 percent) had as many as four water supplies altogether, including those that provided drinking water. Specifically, 0.6 percent of all rural households obtained water from three or more supplies, while 4.4 percent had two. Thus, approximately 1.1 million rural households—5.0 percent—had multiple water supplies, and the remaining 95.0 percent of rural households acquired water from only one supply.

Subnational variation in multiple household water supplies

On a regional basis, there were some slight differences in the number of water supplies serving rural households. In the Northeast, 7.0 percent of rural households had two or more water supplies, and about 2 percent had three or more. By comparison, only 4.0 percent of rural households in the West had multiple water supplies, and no households had more than two. The proportions of rural households having either single or multiple water supplies were very similar in the North Central and the South, although in the South 0.1 percent had four supplies. The only other households that had as many as four supplies were located in the Northeast, where they comprised 0.2 percent of that region's rural households.

As to SMSA and nonSMSA households, 96.7 percent of SMSA households had single water supplies, compared to 94.6 percent of nonSMSA households. Stated the other way, 3.3 percent of SMSA households had multiple water supplies, compared to 5.6 percent of nonSMSA households. While the proportions of SMSA and nonSMSA households with three or more supplies were quite similar, the households using four supplies were all located outside of SMSAs.

The number of supplies serving rural households also varied according to the size of the place in which the household was located. Fully 97.5 percent of the households in large rural communities had only one water supply, while the other 2.5 percent had two. A slightly lower proportion of the households in small rural communities had one supply (94.4 percent), and a somewhat larger percentage had multiple supplies (5.6 percent). Although similar proportions were found in other rural areas (94.8 percent with one supply and 5.2 percent with multiple supplies), all the households with three or more supplies were located in other rural areas.

MAJOR SUPPLY SOURCES

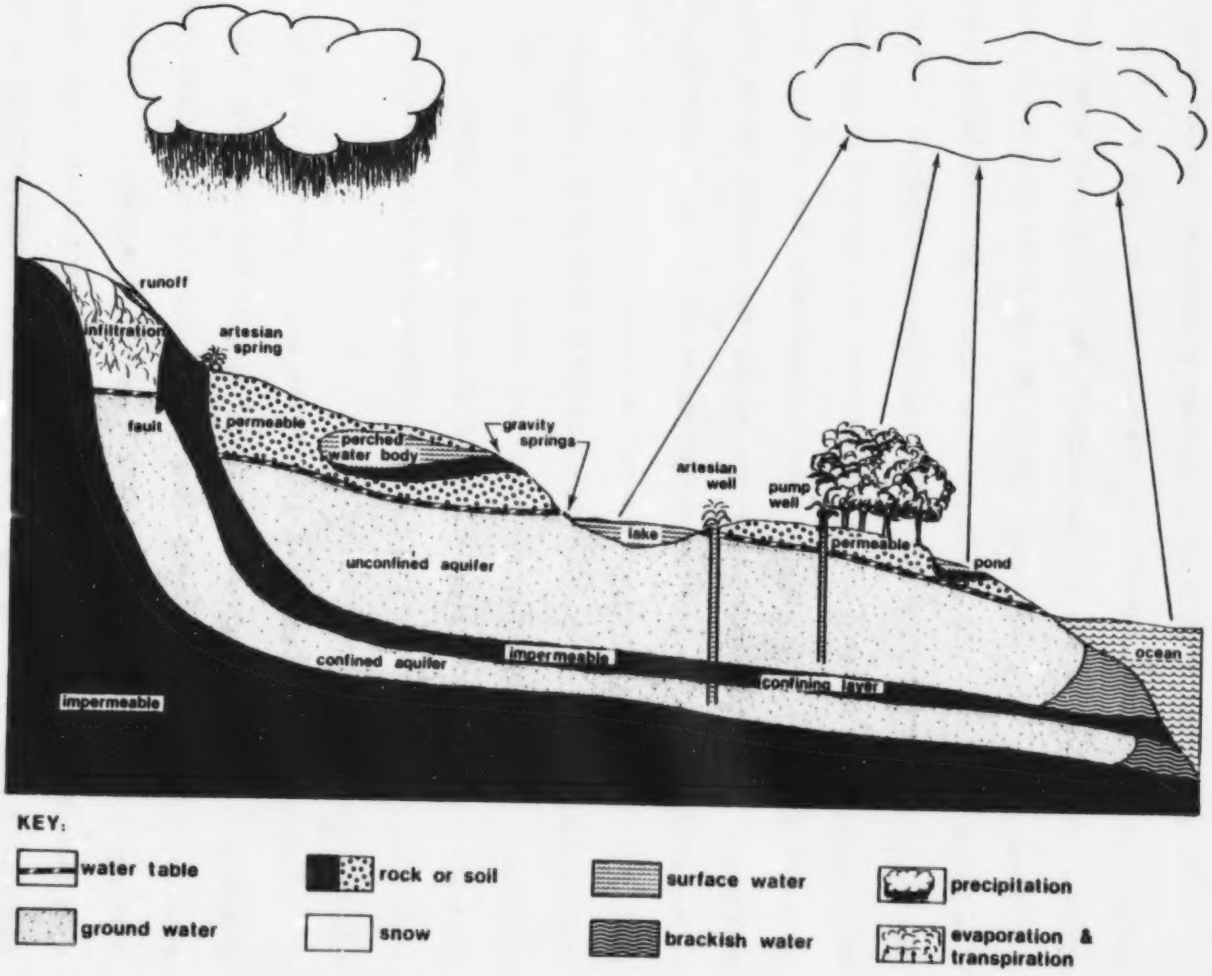
Knowledge of the sources of rural water supplies was potentially important in assessing a number of the qualitative, economic, and institutional aspects of rural water conditions. For example, groundwater generally has been associated with superior quality, although groundwater in consolidated formations like limestone has been thought more subject to contamination than water in unconsolidated formations of sand, gravel, or clay, which tend to filter water seeping down from the surface. Precipitation has been discovered to be contaminated with various natural and artificial pollutants, and it has often proven of inferior quality when left untreated in poorly constructed cisterns. Precipitation-fed cisterns have provided inexpensive, safe water supplies if properly designed, however. Groundwater, on the other hand, sometimes has been difficult and expensive to reach. Surface water often has been available in large quantities—a boon to large centralized systems, although they have had to maintain programs to test and treat the water since it sometimes has been seriously contaminated.

As stated earlier in this report, the term "sources" refers generally to any physical repository of water. More specifically, there are three sources of water available for human consumption and use. One is rain water or precipitation, water that is returning to the earth from the atmosphere. Although most of this water runs off or percolates into the ground, some is collected from the roofs of buildings or special structures and is stored in cisterns or other impoundments. Another source of water is surface water which accumulates in water bodies such as lakes, rivers, and ponds. The third source is groundwater which is confined in aquifers or various strata of the earth's crust.[5] Figure IV-8 illustrates these three basic water sources within the context of the hydrological cycle.

The NSA study centered on the rural household, and there was no provision for intensive geological assessment of the source of household water supplies. Interviewers were aware of certain general differences in the sources of water supplies, but they were not asked to make precise technical distinctions. On the basis of questions asked of household respondents and representatives of multiple-connection systems, supplemented by examination of household premises by the interviewers, the NSA was able to classify the major household water supply sources into the three broad categories presented above.

Except where direct information was available, the source was inferred from the type of supply. Thus, well water was assumed to be groundwater, without considering that the groundwater may have been in an underground perched water body (above the usual aquifer), an unconfined aquifer, or a confined aquifer. Spring water also was assumed to be groundwater, whether or not the spring was activated by artesian pressure as opposed to gravity. (Spring-fed streams and lakes which

Figure IV-8
Hydrological Cycle


runoff
infiltration
artesian spring
fault
permeable
perched water body
gravity springs
artesian well
pump well
lake
permeable
pond
unconfined aquifer
confined aquifer
impermeable
confining layer
ocean
impermeable
KEY:
water table
ground water
rock or soil
snow
surface water
brackish water
precipitation
evaporation & transpiration

were used as water supplies were classified as surface water, however.) Water from a lake, river, stream, pond, or the like was classified as surface water, independent of possible input from ground reservoirs. Cistern water was classified as precipitation.

To these three basic types of sources—groundwater, surface water, and precipitation—were added three other classifications for purposes of the NSA analysis. One classification was "purchased," which designated water that was distributed by a multiple-connection system but which the system had obtained from another supplier. This classification also included purchased bottled supplies. (Since purchased bottled water may be derived from any source and its route may entail several steps between source and consumer, tracing back to the source of purchased water for both individual and multiple-connection systems generally would have been a formidable task—one beyond the capacity of the NSA.) A second additional classification of water sources was "mixed," which designated water from a combination of sources (such as ground and surface), distributed by multiple-connection systems. The third additional classification was constructed to include all water supplies for which the source could not be determined. Generally, this "residual" category included all hauled water supplies, since their sources were not specified, as well as some multiple-connection systems that used sources which could not be identified.

As indicated in Table IV-6, groundwater sources provided water to a much greater proportion of rural major household supplies than any other type. The water in 72.3 percent of all major household supplies (15.9 million) was extracted from a groundwater source, while only 11.4 percent of supplies (2.5 million) came from surface water sources. Approximately 8 percent of all major household supplies (1.8 million) derived water from mixed sources, and purchased water was the source for 6.1 percent of all rural supplies (1.3 million). Consistent with earlier

Table IV-6

Sources of Water for Major Household Supplies

Type of Source	Nation Number of Supplies	 Percent of Supplies
Groundwater	15,886,000	72.3
Surface water	2,504,000	11.4
Precipitation	133,000	0.6
Purchased	1,340,000	6.1
Mixed	1,804,000	8.2
Residual	306,000	1.4
Total	21,974,000	100.0

Each figure in the table is rounded independently; numbers and percentages may not equal rounded totals.

findings that there were relatively few cisterns supplying water to rural households, only 0.6 percent of all major supplies (133,000) had precipitation as a source.

SUBNATIONAL VARIATION IN MAJOR SUPPLY SOURCES

Nationally, groundwater was the predominant source of water for major rural household supplies, and surface water sources were second most common. Between regions, however, substantially different proportions of household supplies were provided water by the various sources, as indicated in Table IV-7. In the North Central, for example, the water from 87.5 percent of the supplies consisted of groundwater, while only 56.7 percent of supplies in the West had groundwater as a source. In contrast with this was the tendency for rural supplies in the West to use mixed sources (17.0 percent) or purchased sources (14.4 percent). Also, in the North Central, an extremely small proportion of supplies (3.5 percent) had surface water sources, compared to the 17.2 percent of supplies that relied upon surface water in the South. Generally, the Northeast and South were relatively similar except that a larger proportion of supplies in the Northeast had groundwater sources (72.7 percent in the Northeast and 66.6 percent in the South), and a greater proportion of supplies in the South depended upon surface water. However, in spite of these dissimilarities, the combined proportions of supplies in the two regions that obtained water from ground or surface water sources differed by less than 1 percent.

In comparison to the supplies of nonSMSA households, a smaller proportion of household supplies within SMSAs had groundwater sources. About 60 percent of SMSA household supplies depended upon groundwater, compared to approximately 78 percent of nonSMSA household supplies. The only other appreciable difference between the supplies of SMSA and nonSMSA households was that a larger proportion of SMSA supplies used water from mixed or purchased sources.

Table IV-7

Regional Variation in Sources of Water for Major Household Supplies

	Number and Percent of Supplies			
Type of Source	Northeast	North Central	South	West
Groundwater	2,684,000	5,438,000	6,191,000	1,573,000
	72.7%	87.5%	66.6%	56.7%
Surface water	384,000	218,000	1,598,000	305,000
	10.4%	3.5%	17.2%	11.0%
Precipitation	12,000	29,000	92,000	0
	0.3%	0.5%	1.0%	0.0%
Purchased	113,000	312,000	514,000	402,000
	3.1%	5.0%	5.5%	14.4%
Mixed	478,000	147,000	709,000	470,000
	12.9%	2.4%	7.6%	17.0%
Residual	23,000	69,000	187,000	27,000
	0.6%	1.1%	2.0%	1.0%
Total	3,693,000	6,213,000	9,291,000	2,777,000
	100.0%	100.0%	99.9%	100.1%

Each figure in the table is rounded independently; numbers and percentages may not equal rounded totals.

Even more pronounced than the preceding differences were the variations among sources in places of different sizes (see Table IV-8). Supplies that provided water to households located in small rural communities or in other rural areas were more dependent upon groundwater sources than supplies of households in large rural communities. While groundwater was the predominant source of supplies for households in large communities (58.9 percent), there was more of a tendency for supplies in these communities to have surface water sources. Also, purchased and mixed sources were more prominent in large communities and other rural areas than in small communities.

Although for most topics treated in this chapter it was not appropriate to compare systems of different sizes, such a comparison was useful with regard to source water. Sources of water are reported from the perspective of systems in Chapter VII. Here, sources of water are reported from the perspective of households using systems of various sizes.

As can be seen from Table IV-9, sources of water differed considerably among households using systems of various sizes. For example, although the predominant source of water for households on individual, intermediate, and community systems was groundwater, the proportions in each category were quite different. While about 93 percent and 92 percent of major supplies at households on individual and intermediate systems, respectively, used groundwater, only about 52 percent of major supplies at households served by community systems did. Again considering only major supplies, much larger proportions of households served by community systems relied on surface water sources (20.5 percent), mixed sources (16.2 percent), and purchased sources (11.2 percent), compared to households using individual and intermediate systems. The only other significant difference was that a comparatively large proportion of major supplies at households served by intermediate systems used surface sources (7.0 percent).

Table IV-8

Size-of-Place Variation in Sources of Water for Major Household Supplies

Type of Source	Number and Percent of Supplies		
	Large Rural Communities	Small Rural Communities	Other Rural Areas
Groundwater	1,394,000	1,228,000	13,264,000
	58.9%	81.4%	73.3%
Surface water	508,000	166,000	1,830,000
	21.4%	11.0%	10.1%
Precipitation	0	0	133,000
	0.0%	0.0%	0.7%
Purchased	215,000	83,000	1,043,000
	9.1%	5.5%	5.8%
Mixed	241,000	27,000	1,536,000
	10.2%	1.8%	8.5%
Residual	11,000	6,000	289,000
	0.5%	0.4%	1.6%
Total	2,369,000	1,509,000	18,095,000
	100.1%	100.1%	100.0%

Each figure in the table is rounded independently; numbers and percentages may not equal rounded totals.

Table IV-9

Size-of-System Variation in Sources of Water for Major Household Supplies

	Number and Percent of Supplies		
Type of Source	Individual System	Intermediate System	Community System
Groundwater	8,168,000	2,046,000	5,672,000
	93.2%	91.8%	51.7%
Surface water	93,000	156,000	2,255,000
	1.1%	7.0%	20.5%
Precipitation	133,000	0	0
	1.5%	0.0%	0.0%
Purchased	102,000	3,000	1,235,000
	1.2%	0.2%	11.2%
Mixed	0	22,000	1,782,000
	0.0%	1.0%	16.2%
Residual	269,000	0	37,000
	3.1%	0.0%	0.3%
Total	8,765,000	2,228,000	10,981,000
	100.1%	100.0%	99.9%

Each figure in the table is rounded independently; numbers and percentages may not equal rounded totals.

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[5] Wright, pp.11-12.